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SOUTHWEST RESEARCH INSTITUTE ASSISTANCE TO NASA IN BIOMEDICAL AREAS OF THE TECHNOLOGY UTILIZATION PROGRAM

FINAL REPORT

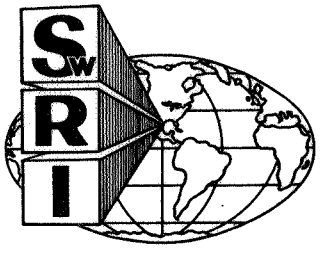
1 February 1969 - 24 August 1970

Contract No. NASW-1867
SwRI Project No. 13-2538

Prepared for

Chief, Dissemination Branch, Code (UT)
Technology Utilization Division
Office of Technology Utilization
NASA
Washington, D. C. 20546

24 August 1970



SOUTHWEST RESEARCH INSTITUTE
SAN ANTONIO HOUSTON

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Prepared by: David F. Culclasure
Linda Eckhardt

Approved:

W. Lyle Donaldson

W. Lyle Donaldson, Director
Department of Bioengineering

ABSTRACT

The NASA Biomedical Application Team at Southwest Research Institute has been active in an experimental program of technology transfer. It was supported by NASA Contract No. NASW-1867 for the 1 February 1969 to 1 September 1970 reporting period. The Biomedical Application Team, a multidisciplinary group of scientists and engineers, acts as an information and technology interface. It provides valuable biomedical research and clinical medicine correlations between NASA and individuals or institutions or agencies. The Southwest Research Biomedical Application Team presently is staffed by:

Ray W. Ware, M.D.
C. William Hall, M.D.
David F. Culclasure, Ph.D.
Robert S. Schuhmann, Ph.D.
Edward E. Dean, D.V.M.
Charles J. Laenger, Sr.
Samuel G. Schiflett
Robert L. Wilbur
Linda L. Eckhardt
Dennis C. Jamvold

The following 38 medical institutions participated in the Biomedical Application Team program during the report period.

Baylor University Medical School
Houston, Texas

The Claremont Colleges
Claremont, California

Gallup Indian Medical Center
Gallup, New Mexico

Georgia Institute of Technology
Atlanta, Georgia

Hot Springs Rehabilitation Center
Little Rock, Arkansas

Loma Linda Medical Center
Loma Linda, California

Los Angeles County Hospital
Los Angeles, California

Northwest Institute for Rehabilitation
Seattle, Washington

Palo Alto Medical Research Foundation
Palo Alto, California

Rancho Los Amigos Hospital
Downey, California

St. Josephs Hospital
Phoenix, Arizona

Scott and White Hospital & Clinic
Temple, Texas

Stanford University School of Medicine
Stanford, California

Texas Institute for Rehabilitation and Research
Houston, Texas

University of Alabama Medical School
Birmingham, Alabama

University of Arizona Medical School
Tucson, Arizona

University of California Medical School
Davis, California

University of Florida
Gainesville, Florida

University of Florida Medical School
Gainesville, Florida

University of Oklahoma Medical School
Oklahoma City, Oklahoma

University of Southern California Medical School
Los Angeles, California

University of Texas Medical Branch
Galveston, Texas

University of Texas Medical School
San Antonio, Texas

University of Texas Southwestern Medical School
Dallas, Texas

University of Utah Medical School
Salt Lake City, Utah

University of Washington Medical School
Seattle, Washington

Veterans Administration Hospital
Albuquerque, New Mexico

Veterans Administration Hopsital
Bay Pines, Florida

Veterans Administration Hospital
Birmingham, Alabama

Veterans Administration Hospital
Dallas, Texas

Veterans Administration Hospital
Gainesville, Florida

Veterans Administration Southern Research Support Center Hospital
Little Rock, Arkansas

Veterans Administration Hospital
Long Beach, California

Veterans Administration Hospital
Sepulveda, California

Veterans Administration Hospital
Shreveport, Louisiana

Veterans Administration Hospital
Temple, Texas

Western Research Support Center
Sepulveda, California

Wilford Hall Hospital
Lackland AF Base, Texas

During this reporting period, the Biomedical Application Team has identified new problems for investigation. It accomplished 11 transfers of technology and identified 29 potential transfers. On 24 August 1970 it had a total of 180 problems under active investigation.

There have been many significant transfers of technology. They include flexible, conducting electrodes for use in treating patients suffering from angina pectoris; unique NASA instrumentation for use in a screening test for cystic fibrosis; and specialized instrumentation for use in ecological investigations.

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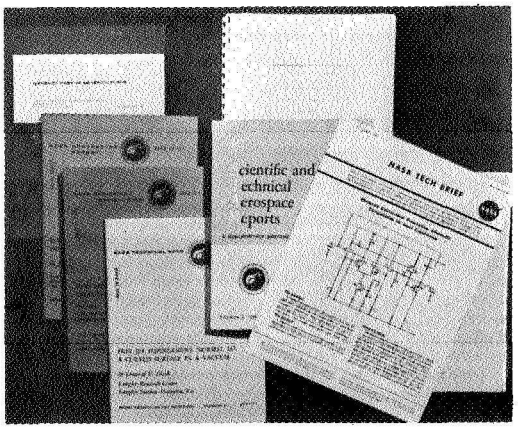
I. INTRODUCTION

Over the past two decades, billions of dollars have been invested in aerospace research and development. These efforts, designed to maintain this country's leadership in pushing forward the frontiers of man's knowledge concerning the universe, have enabled the United States to span a distance of 240,000 miles, place two astronauts on the lunar surface, and then return them safely to earth.

NEED FOR DISSEMINATION

Research and development associated with the space effort has created a tremendous stockpile of knowledge. This stockpile, which presently consists of more than 750,000 scientific and technical documents, is increasing at the rate of approximately 75,000 documents per year. Much of the new knowledge and technology found in this stockpile is directly applicable to areas other than the aerospace effort. For this reason, several years ago NASA initiated an active program to assure the widest practicable dissemination of scientific and technological developments resulting from the Nation's space effort.



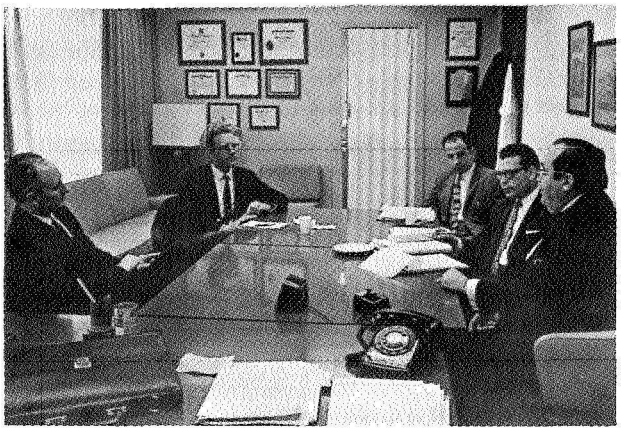
Typical Aerospace Scientific and Technical Documents

SPECIAL COMMUNICATIONS PROBLEMS

It soon became apparent that the usual methods of communication, such as special publications and news releases, were failing to meet the particular needs of biomedical researchers and practitioners. Special problems were encountered in communicating knowledge gained by physical scientists involved in the space effort to scientists in the biomedical community. This resulted in the great stream of information flowing from the aerospace research centers to those in clinics, hospitals, and rehabilitation centers becoming known indirectly and belatedly, if at all.

FORMATION OF BIOMEDICAL APPLICATIONS TEAMS

An interface or two-way communication system between physical and biological scientists was clearly needed to permit feedback between aerospace and biomedical communicators. Consequently, an experimental approach involving Biomedical Applications Teams was devised by NASA's Office of Technology Utilization to close this communications gap. These teams consist of small groups of biological and physical scientists located at selected independent research centers. Each team is equipped with firsthand knowledge of areas of active research at NASA and contractor facilities, is familiar with NASA's computer-indexed collection of scientific and technical information, and is adept at designing search strategies which optimize information retrieval. The teams thus represent a human connection between NASA, its research centers and contractors, and the biomedical researchers and practitioners at work in medical schools, institutes, and hospitals. They also provide



Biomedical Applications Team

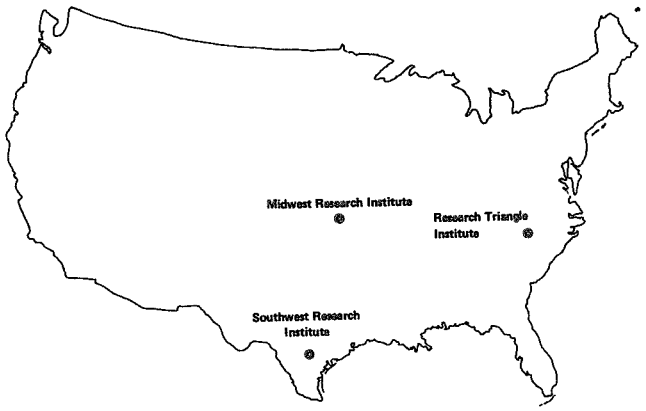


Figure 1. Location of the NASA Biomedical Applications Teams

an experimental framework by which the transfer process can be analyzed.

BIOMEDICAL APPLICATIONS TEAMS FUNCTIONS

Whereas NASA purposely selected the different Biomedical Applications Teams to contain different professional backgrounds–in physics, engineering, and medicine–each team's operational approach to the application of aerospace knowledge to medical research problems is essentially the same. The teams *filter, encode,* and *amplify* communications, functioning as an interface between the aerospace and biomedical researchers, helping to identify biomedical problems to which aerospace technology may be applicable. NASA's Office of Technology Utilization has three Biomedical Applications Teams (see Fig. 1) in operation at present: at Midwest Research Institute, Kansas City, Missouri; at Research Triangle Institute, Durham, North Carolina; and at Southwest Research Institute, San Antonio, Texas.

PROBLEM ACCEPTANCE

Understandably, the teams are empowered primarily to attack problems which (1) bear most meaningfully and directly upon advancing research and development in the biomedical community, and (2) are likely to benefit from some aspect of prior or ongoing research and development being conducted as part of the Nation's space effort. Several years' experience in the technology transfer process, plus an awareness of the scope of the aerospace research effort, enables the teams to realistically evaluate the probability of a transfer being effected in a given case. Problems submitted are accepted–or rejected–only after careful study by the team.

THE FIRST STEP–PROBLEM DEFINITION

Each problem accepted is stated in functional, nondisciplinary language which is understandable by aerospace engineers as well as medical researchers in the form of a "Problem Statement." This statement is used not only to devise a strategy for computerized searching of the NASA Aerospace Data Bank, but may also be circulated to Technology Utilization Officers at NASA field installations, who will seek possible solutions to the problem from NASA scientists and engineers.

Two points are especially worthy of note at this juncture. The first is that the Biomedical Applications Program is a problem-solving endeavor as opposed to a research oriented literature searching activity; the Teams' activities resolve around seeking solutions for discrete, well-defined technical problems. The second point is that only problems which meet certain criteria can be accepted, due to both limited manpower and the basic purpose of the effort–which is to transfer aerospace related technology to biomedicine.

THE NEXT STEPS

The problem solving approach used by the Biomedical Applications Teams embodies a problem definition-solution search methodology which:

- Provides access to NASA scientific and engineering expertise,
- Focuses multidisciplinary expertise on discrete, technological problems, and
- Facilitates innovative secondary applications of aerospace related technology.

Basically, the methodology employed is to carefully define important biomedical problems for which it appears relevant aerospace technology may exist, and then systematically search both computerized aerospace data files and NASA research centers for potential solutions.

After an item, or groups of items, of aerospace technology have been identified as potentially useful, the team collects the maximum information available. This could involve retrieving pertinent information or obtaining hardware or models for evaluation if such is indicated and feasible. The team then makes a preliminary evaluation to determine whether or not the item or information, either in present or modified form, is applicable to the problem at hand. Items that survive this preliminary evaluation are then transmitted to the researcher or practitioner who posed the original problem for more thorough trial in laboratory and clinic. Often, the problem originator's evaluation will indicate that some modification or adaptation is needed to make an item suitable for biomedical transfer. The adaptation required may range from minor change to a substantial development effort. The evaluation and adaptation stages of the transfer process are closely interrelated, and, frequently, a number of evaluation-adaptation-evaluation cycles are needed to establish the medical value of an item of aerospace technology.

TRANSFER–THE PROGRAM'S ULTIMATE AIM

A technology transfer–utilization of aerospace technology for purposes other than that for which it was intended–represents the ultimate aim of the Biomedical Applications Teams effort. Transfers are of singular importance in the continuing NASA effort to insure, for the public sector, the greatest possible return for dollars invested in the space effort. When a transfer has been accomplished, the problem originator is asked to aid in documenting the transfer so that the information can be distributed. After a transfer has been effected, the participating researcher or practitioner may prepare papers for presentation at medical meetings and for publication in medical journals, and the engineers or physical scientists involved may also prepare papers to present to their own professional groups. Also, information pertaining to the transfer may be presented by NASA to equipment manufacturers through seminars, written reports, and personal contacts.

II. SOUTHWEST RESEARCH INSTITUTE BIOMEDICAL APPLICATIONS TEAM ACCOMPLISHMENTS DURING THE REPORT PERIOD

TECHNOLOGY TRANSFERS ACCOMPLISHED

Employing the techniques described in the Introduction, the SwRI Biomedical Applications Team was able to achieve a number of significant technology transfers. The problems solved and a description of the aerospace technology which facilitated their solution are outlined in the following problem summaries:

PROBLEM BLM-12 *Flexible Electrode for Stimulating the Carotid Sinus Nerve*

The investigator required a biologically inert, soft, flexible conducting electrode to provide an electrical connection between the lead from an implanted cardiac pacemaker and the surgically exposed carotid sinus nerve. The connection was needed to provide electrical stimulation of the carotid sinus nerve for relief of pain associated with angina pectoris. A pair of rigid platinum electrodes in silicone foam rubber previously had been used to make the connection. These rigid electrodes contacted and stimulated only one side of the nerve. Rigidity also tended to damage delicate nerve tissue. The investigator also had tried to overcome this problem by adding various conductive particles such as platinum and carbon to Silastic rubber. Results had been variable and unsatisfactory. He needed a soft, flexible wraparound electrode with a consistency much like that of Silastic rubber. Major contraints concerning this problem were: the electrode material must be a good conductor; the electrode must be biologically inert; and the material must be suitable for long-term implantation (at least 5-yr duration).

The team accepted the problem and initiated a computer search to determine if published material was available concerning NASA flexible electrode fabrication technology. The search failed to reveal material directly leading to solution of the problem. The team then searched for a NASA research center where the technology could be found. They located a researcher at the NASA Ames Research Center who was working with flexible, conductive compounds. With the assistance of the Ames Research Center Utilization Officer, arrangements were made to have several flexible electrodes fabricated. They satisfied all specifications required by the problem originator.

The specialized technology available at NASA Ames Research Center permitted fabrication of a biologically inert, flexible electrode (Fig. 2) which could be surgically implanted in a manner to totally embrace the carotid sinus nerve, thus providing an effective electrical connection between the nerve and a lead from an implanted cardiac pacemaker. Heretofore, rigid electrodes were implanted, a procedure which involved the risk of (1) injury to the delicate carotid sinus nerve and (2) poor performance due to contact by rigid electrodes with only one side of the nerve.

The initial assistance provided to the researcher, plus NASA Ames willingness to continue development work to improve the flexible electrode by using platinum elastomer, is expected to significantly advance ongoing research designed to perfect the use of carotid sinus nerve electrical stimulation to relieve the crippling pain of angina pectoris.

PROBLEM SWC-9 *Noise Level Correction for Audiometric Measurements*

Investigators at a Southwest medical institution are perfecting a technique using the EEG to test hearing acuity of young children. Thousands of children presently considered to be mentally retarded are believed to be suffering instead from hearing difficulties. The hearing difficulties have cut them off from auditory interchanges with their environment. Such auditory interchanges are needed to develop their intellect. If hearing defects can be identified early in infancy and appropriate (e.g., hearing aid) remedial measures initiated, the investigator is convinced that many youngsters can be protected from becoming functional mental retardates. The investigator has developed instrumentation to provide averaged EEG signals during periods of auditory stimulation. This method quite effectively reflects whether a child hears when auditory

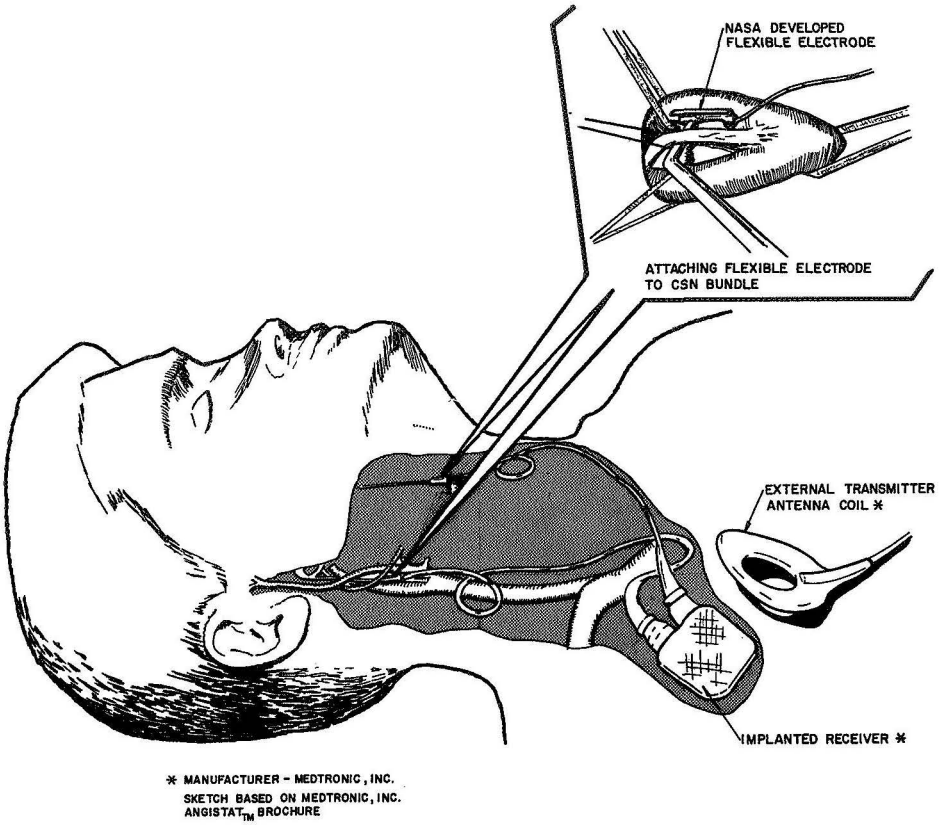


Figure 2. Sketch Depicting the NASA-Developed Biologically Inert Flexible Electrode

stimuli are administered. The investigator has encountered several problem areas. Youngsters dislodge the electrodes and disrupt screening procedures. Excessive preamplifier noise also interfered.

The team was able to suggest a solution regarding the electrode dislodging problem. They proposed use of an EEG helmet system which has been developed at the NASA Ames Research Center (described in the potential transfer section of this report). The team researched the NASA data bank concerning the noise level problem. Document A66-12989 described a high performance, miniaturized preamplifier for biological applications, a potential solution to the problem. A prototype was built, checked by the team and sent for evaluation to the problem originator. The investigator was pleased with the performance of the prototype and is using it for his measurements.

The following illustrates the differences between the investigator's original prototype and the proposed NASA solution:

	Investigator's Prototype	NASA Prototype
Voltage Gain	1,000	1,000
Input Z	22M	24M diff
Output Z	50	50
Noise Referred to Input	3 volts p-p	1.4 volts p-p
Bandwidth	3 to 100 Hz	0.15 to 100 Hz
Common-Mode Rejection	20,000 to 1	25,000 to 1

A 2-to-1 noise improvement was achieved through application of the NASA-developed unit. Figure 3 illustrates this preamplifier system as mounted on the proposed helmet.

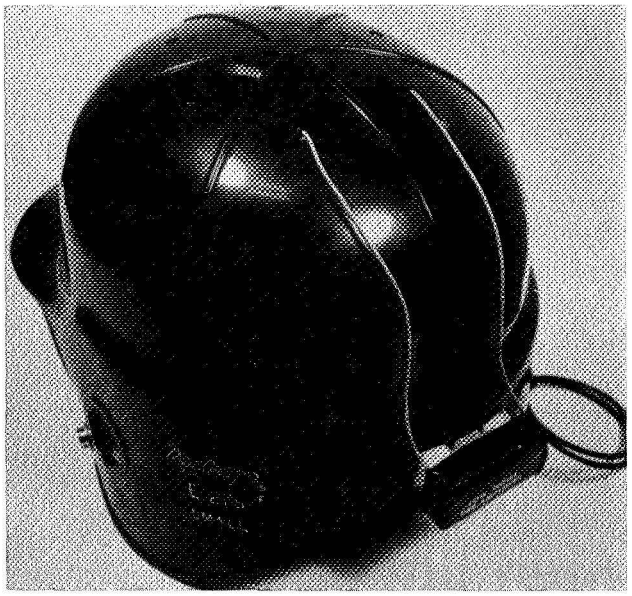


Figure 3. NASA-Developed Preamplifier Mounted on the EEG Helmet

PROBLEM CAP-2 *Galvanic Skin Response Electrodes for Long-Term Applications to Human Subjects*

Researchers at a West Coast university are conducting research studies involving the behavioral patterns of adolescent delinquents. One phase of this research involves telemetering the galvanic skin response (GSR) of adolescent delinquents as they interact in their natural social setting, e.g., home, school, and hangout. In the study, dry electrodes are applied to the plantar region (inner aspect of the instep) to acquire the GSR, with the signal being conducted from the foot via a connecting link concealed in the trouser leg to a transmitter placed at a convenient concealed location on the delinquent's person. Whereas effective techniques have been developed for attaching GSR electrodes to the fingers with relative ease, they cannot be used for the present application. This is for several reasons: (1) they involve some disruption of activity and (2) more importantly, the delinquent's peers will not accept him within the social unit if it is obvious that he is instrumented in some manner, such as with highly visible finger electrodes. Currently, dry electrodes (silver discs soldered to 20 ga polyvinyl-insulated copper wire) are being applied by investigators to the plantar region of the foot. These electrodes are difficult to affix for extended use, involve considerable motion artifact, and tend to be uncomfortable during walking.

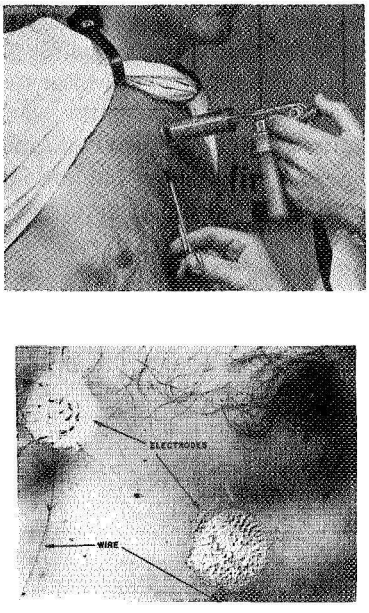


Figure 4. Applying the NASA-Developed Dry Electrodes

The investigator asked that NASA technology be explored to see if technology relating to electrodes, suitable for taking the GSR (galvanic skin response) of human adult subjects was available. The electrodes desired had to be amenable to long-term application (periods of 24 hr or longer) without impairment of sensitivity and had to minimize the occurrence of motion-induced artifacts. Also, the desired electrodes had to be small enough to permit them to be worn comfortably when applied to the plantar region.

The team accepted the problem and searched NASA literature to identify any aerospace technology bearing on the electrode application specified. NASA Technical Note TN D-3414, *Dry Electrodes for Physiological Monitoring* appeared to have particular application to this problem and was retrieved from NASA literature. The document described a method which had been developed at NASA Flight Research Center, Edwards, California. Figure 4 illustrates the very rapid spray application onto the skin of electrocardiograph electrodes.

This method, which permits rapid instrumentation of subjects in an operational environment provides a finished electrode which is dry and is less than 0.01 in. thick. The NASA-developed method of

electrode application is well suited for the active subject, such as the adolescent delinquents used in the research described above. In addition, the technique is reliable, while at the same time interfering in no way with the movement or comfort of the experimental subject. Importantly, the spray-on electrodes are resistant to motion artifacts; are noninjurious and nonirritating in prolonged use; do not require shaving prior to application; and are easy to apply. In this latter regard, NASA experience indicated that with a minimum of practice, two technicians can instrument a test subject in less than 3 min.

PROBLEM HUV-18 *Microanalysis of Mucus-Secreting Cells*

The problem originator was searching for a technique to analyze the chemical constituents of microscopic portions of mucus-secreting, salivary-gland cell specimens from cystic fibrosis patients. Secretions of cystic fibrosis patients are known to show high sodium concentrations as compared to "normal" patients. This disease affects approximately 1 out of every 1000 infants. The investigator believes that a method to determine these abnormally high sodium concentrations could form the basis for a screening test to detect cystic fibrosis in early stages.

The team accepted the problem and searched the NASA Data Bank. They learned the NASA Manned Spacecraft Center had a unique, scanning electron microscope and microprobe (Fig. 5) having capabilities of performing chemical analyses on a micron scale by analyzing the emitted x-radiation generated by an electron beam. Because of its unique ability to analyze specimens of considerable thickness, the team envisioned that this specialized equipment could be used to rapidly detect abnormality in biochemical structures and functions which are symptomatic of cystic fibrosis.

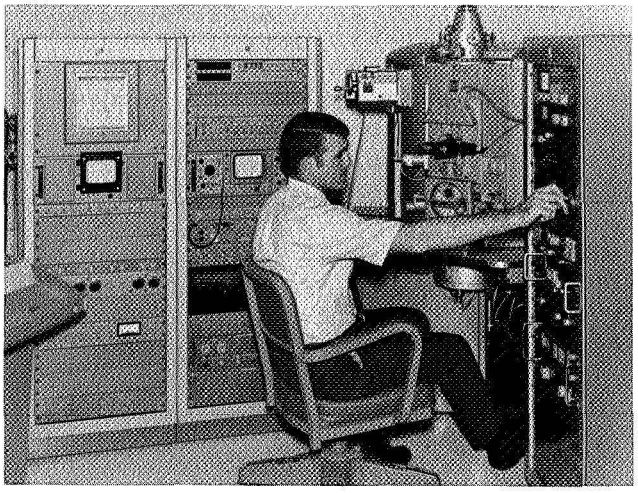


Figure 5. The Manned Spacecraft Center Scanning Electron Microscope and Microprobe

Working through the NASA Manned Spacecraft Center Technology Utilization Office, the team made arrangements for the investigator to have access to the scanning electron microscope and microprobe for 8 hr per week. The preliminary results achieved through use of the specialized equipment have been promising. The investigator is encouraged to believe this may lead to successful development of early screening technique for detection of cystic fibrosis.

PROBLEM NWR-6 *The Effects of Electromagnetic and Acoustic Fields on Living Organisms*

The problem originator desired to learn as much as possible from NASA technology pertaining to the effects of physical fields (ultrasonic and electromagnetic) on living organisms and tissue. Based on this information, the problem originator anticipated formulating specific research to attack problems in this area which have not been adequately solved. He expressed interest in both thermal and nonthermal effects of these physical fields. Through the use of modern computer technology, plastic modelling techniques, and thermographic instrumentation, the investigator hoped to quantitatively improve the research approaches to these problems.

Since the problem originator's requirement was primarily informational in nature, a computerized search of the NASA Data Bank was executed to investigate and produce literature concerning the effect of nonionizing radiation (ultrasonic, radio, radar frequencies, 20 kHz to 100 GHz) on living organisms (man, animals). The search also included the effects of electric and magnetic fields. The results of the search were used by the problem originator to prepare a document in a study program for the Biomedical Engineering

Society. The reports, which included updated reports and Russian translations from the NASA Data Bank, are expected to play an important role in revision of Federal standards regarding electromagnetic safety levels.

PROBLEM SFM-3 *Improved Monitoring of Heart Cell Parameters*

The researcher was investigating the effect of various pharmacological agents upon several parameters of isolated heart cell activity, such as rate of contraction. At the time the problem was submitted, observation of this cellular activity was performed visually on a periodic basis by a human observer using a phase contrast microscope. An automated system was needed to provide for continuous monitoring of the heart rate.

Several avenues were utilized to effect a solution to the problem, including a computerized search of the NASA Data Bank and a liaison with researchers at various NASA research centers. A data search failed to yield a solution to the problem; however, it provided much valuable information for the researcher. Solution to an important portion of the problem was attained with assistance provided by NASA-Ames Research Center, where a linear, low-frequency response cardiotachometer had been developed for employment in animal experimentation. Although in its existing form the NASA-developed tachometer failed to meet the precise requirements of the researcher, NASA was able, by some reengineering effort, to modify the equipment to meet the researcher's needs. This involved circuit modifications designed to provide a lower linear frequency limit of 10 bpm which was needed for the researcher's particular application. Prior to reengineering, the NASA tachometer's lower linear frequency limit was 30 bpm. The reengineering effort also involved the development of an improved interface between the recording apparatus and the cardiotachometer, thereby facilitating the use of the NASA-developed tachometer in the research effort pictured in Figure 6.

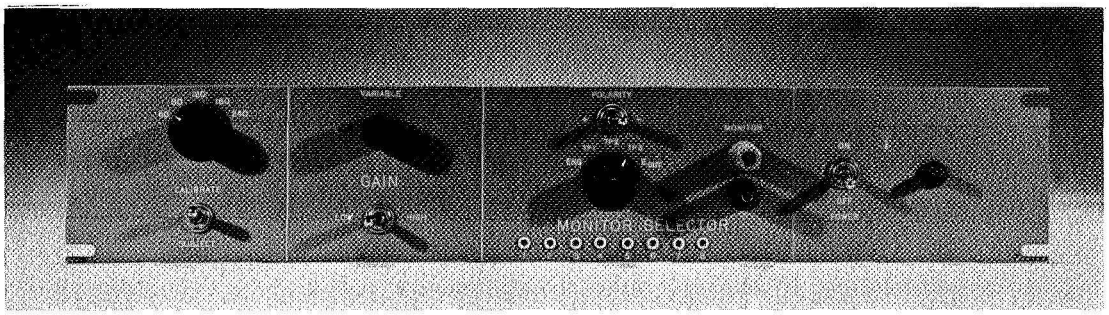


Figure 6. NASA-Developed Linear, Low-Frequency Response Cardiotachometer

Research, such as that described above, in which the effects of various pharmacological agents are evaluated upon isolated cardiac cells, is expected ultimately to lead to techniques whereby localized heart therapy will be possible. That is, instead of being constrained to treat the entire heart, the techniques will permit treatment of localized, damaged or diseased areas of cardiac musculature. In terms of benefits to the researcher, the NASA-developed and reengineered cardiotachometer facilitated research progress by providing a means for continuously, automatically monitoring the activity of isolated heart cells or colonies of cells. Prior to the availability of the NASA equipment, observations were crudely performed by visual observation using a phase contrast microscope, during which time the cellular contractions were counted. Out of practical necessity, this important phase of the research had to be accomplished on a periodic rather than on a continuing basis. The NASA-provided equipment substantially increased the accuracy of observations, saved untold man-hours of observational effort, and significantly expedited progress on the overall research task. In addition, the data provided by the computerized literature search proved to be extremely useful to the research in proceeding toward the development of a mathematical model dealing with the force—or amount of work—involved in the contraction of cardiac cells.

PROBLEM UTM-19 *Electrodes for Measurement of Heart Rate in Active Experimental Animals*

The investigator is engaged in experiments which involve the measurement of heart rate on dogs running on a treadmill at a rate from 1 to 6 miles per hour. This requires the electrode attachment to the animals and hard wire leads routed to the recording instruments. Problems have been encountered in attaching the electrodes with subcutaneous, taped and strapped electrode placement techniques which makes this method unacceptable. They do not permit acquisition of reliable data, due to the activity of the dog, either producing motion artifacts or tearing the electrodes away from the skin.

The investigator asked for any NASA technology concerning unique electrodes or electrode placement technique which would assist in overcoming the difficulties described above. The electrodes and/or attachment technique had to be nonirritating to reduce the possibility of the dog trying to remove the electrodes.

The dry electrode method developed at the NASA Flight Research Center, Edwards, California, for EEG and ECG electrode application to active human subjects appeared to meet the requirements outlined by the researcher. The method developed is rapid, well suited to the active experimental animal (Fig. 7), and results in neither bulk nor significant discomfort. The experimental animal rapidly adjusts to the presence of the dry electrodes and does not notice their presence. The electrodes being nonirritating, the experimental animal is not inclined to try to pull, claw, or bite them off the skin. A comprehensive packet of materials concerning the electrical characteristics of the electrodes, their application, use and commercial source was provided to the investigator. After evaluating the technique, the investigator found that the NASA-developed dry electrode technique met his particular requirements.

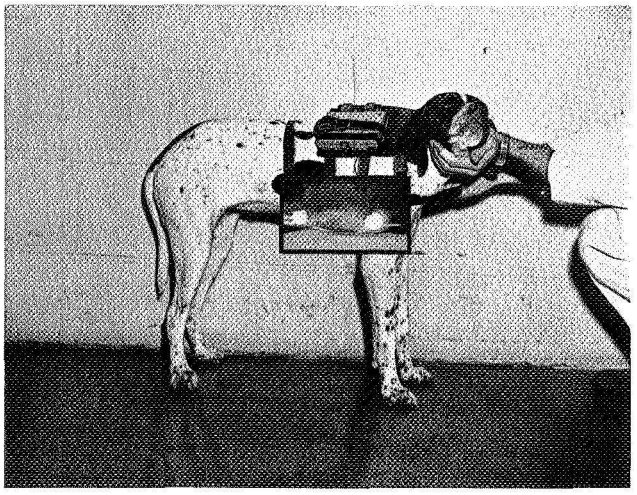


Figure 7. NASA-Developed Spray-On Electrode Technique Being Used with an Experimental Animal

Use of the NASA-developed spray-on electrode technique will permit the investigator to more adequately measure heart rate on experimental animals subjected to extreme activity on a treadmill. In the past, such measurement has been difficult to obtain because the activity of the animal interfered with adequate placement of the electrodes, and their retention in place. Major benefits to be derived from use of the technique involve increased reliability of the data gained (by minimizing motion artifacts) and saving of time to gather data (by minimizing the necessity to repeat an experimental sequence because the animal tears the electrodes off).

PROBLEM WSM-6 *High Power Infrasonic Wave Generator*

Researchers at a West Coast university are studying the disease atherosclerosis by means of analog mechanical/fluid models. It is anticipated that such studies, which focus upon the dynamic behavior of a model of atherosclerosis, may well lead to the development of additional means of assessing the severity of atherosclerosis as the disease develops.

A primary aspect of these studies involves the correlation between the dynamic stresses generated in experimental situations and their correlation to analog methods. This, in turn, involves several distinct considerations: the experimental generation of stress waves, and their detection, principally in a liquid filled tube; and the analysis of the phenomena, principally leading to the numerical solution of a simulated

condition. In the study, emphasis has been placed on the experimental portion, particularly with regard to the generation and detection methods for dynamic stresses. Methods used to generate the required pulsatile pressure disturbances included internal pistons and wall deformation devices. However, these sufficed only to provide gross means of experimentally simulating hypothetical dynamic stress situations, often producing much confusion when attempts are made to interpret the results.

Previous methods for investigating the dynamic behavior of fluid filled tubes have always assumed that the wall properties would remain uniform over the length of the tube. Attempts to apply this information to the problem of pulse wave transmission in arteries have been successful because of the assumption of uniform wall properties. In addition, consideration was not given to the time varying properties of atherosclerosis. The possibility of obtaining diagnostic information about the composition of the arterial wall, in addition to the presently attainable geometric information, will lead to the detection of pathological situations at an earlier time in its history than can presently be done.

To solve the problem outlined above, the investigator needed a pressure generator programmable by analog signals, and capable of producing pressures ranging from 0 to 300 mmHg, with frequencies from DC to 100 Hz.

Upon receipt of the problem, the team was able to make an immediate recommendation concerning a possible solution due to awareness of related technology at Ames Research Center. This installation had available a dynamic servo-controlled electromagnetic shaker capable of operation at close to the DC level and upwards to 100 Hz or better with a force output of 50 pounds. The device was developed originally for study of aerodynamic flutter of wing surfaces. Arrangements were made to have the equipment loaned on a long-term basis. As a result, the investigators have been able to generate impulses and continuous waves at force levels not previously possible.

Availability of the NASA-developed electromagnetic shaker is expected to facilitate development of a new type of diagnostic procedure for atherosclerosis that will be able to assess changes in the arterial wall at times significantly before the plaque begins to invade the lumen.

PROBLEM UTM-11 *Motion Transducer for Studies on Small Animals*

Human ecology research programs directly related to high population problems are prompted by symptoms of pollution, increased crime rates, civil disputes, riots, and drug abuses. An institution in the Southwest is investigating high density population responses to adverse stimuli of electrical shock, smoke, dust, crowding, and odors. They use small birds and rodents as models to simulate the human situation. Instrumentation is used to measure posture, position, and activity of these test animals to better understand responses to one or more adverse stimuli. Measurement of posture and reaction time for head movements of a pigeon subjected to an electrical stimulus is a typical problem. The problem originator previously had measured posture with a handmade, 3-position mercury switch. It did not provide information on reaction time. The switch also was heavy and cumbersome. It was made of glass and was therefore fragile. All these factors tended to nullify results because of fatigue, overcompensation, and breakage.

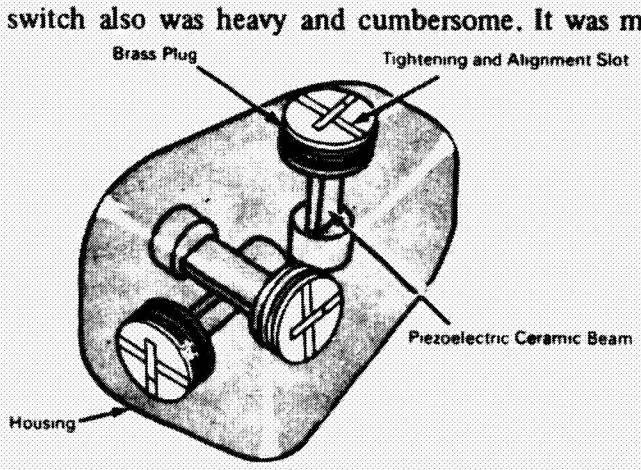


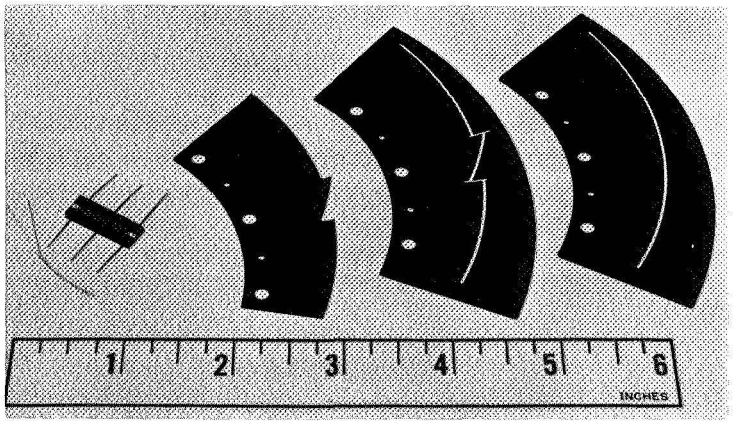
Figure 8. NASA-Developed Triaxial Accelerometer Is Now Being Used in Ecological Research

The team accepted the problem and found the solution in NASA Tech Brief 66-10534, *Miniature Piezoelectric Triaxial Accelerometer Measures Cranial Accelerations.* The Whittaker Corporation provided the accelerometers and no modifications of the NASA technology were required (Fig. 8).

The problem originator feels that his use of the NASA accelerometer will simplify ecological research and allow more time for field studies.

PROBLEM UTM-13 *Small Animal Posture Indicator*

The problem originator is studying aggressive behavior in a continuation of the foregoing research. He is subjecting small animals and birds to confrontations with others of the same species. He discovered that the animals react to different stimuli by striking certain poses. They maintain this pose until the stimulus is removed or changed. The investigator had to visually observe the postures or poses over extended periods of time.



Note: Developed for NASA by TRW Systems.

Figure 9. NASA-Developed Gimbal Angle Sensor Now Being Used for Ecological Research

The team accepted the problem and was able to propose a solution found in NASA Tech Brief 68-10315, *Gimble Angle Sensor.* The problem originator is using a lightweight version of the NASA sensor, shown in Figure 9, to fabricate the system. He feels this innovation will greatly reduce the required laboratory man-hour effort. This permits acceleration of field studies at the ecology preserve.

PROBLEM UOF-1 *Tape Head Maintenance for Hospital Computers*

In the past, magnetic tape recorders at a Southeastern medical school, which were used for measurement of ECG and EEG frequently, became inoperable at the tape head after 15 min of operation, requiring shutdown and head maintenance before continuing to record the small biopotential signals. This shutdown resulted not only in loss of critical data but was also costly in time.

Initial efforts by the problem originator and commercial representatives whom he called upon for assistance failed to determine the cause of the tape head contamination. The problem originator, upon noticing that NASA utilized the same type tape recorders with no apparent difficulty, submitted the problem to the Team for consideration. Discussion of the problem with the Technology Utilization Officer at Marshall Spaceflight Center resulted in several suggestions that held the promise of rectifying the problem. These included suggestions that oxide polished tapes be used and that air balance equipment governing the environment around the tape decks be kept operating 24 hr a day to maintain constant humidity-temperature relationships in the tape recorders.

The problem originator has applied the NASA suggested remedial action and reports continuous running times of the equipment up to 1 hr, and he anticipates even longer runs in the future.

POTENTIAL TECHNOLOGY TRANSFERS

In addition to the transfers of aerospace technology listed above, the team uncovered relevant aerospace technology which holds the potential for solving twenty-two other important biomedical problems submitted for consideration. These are categorized as potential transfers since final evaluation of the contribution made by the NASA technology identified by the team remains pending for one or a number of reasons. For example, the NASA technology might require modification before it can be used; only a prototype NASA unit might be available which cannot be released to the investigator; or the investigator's existing funding level might not permit evaluation of the suggested technology at the present time. A summary of problems for which potential transfers of aerospace technology are envisioned follows.

PROBLEM UTM-9 *Tidal Volume Measurements in Respiration Studies*

Studies relating to definition and diagnosis of emphysema and other respiratory diseases require quantitative information on tidal volume (i.e., volume of air inhaled and exhaled) in conjunction with other physiological parameters. In his investigations, the problem originator exercises his subjects and attempts to measure this tidal volume with a high resistance transducer (pneumotachograph). The combined effects of the condition of the patients and a high resistance transducer functioned to increase the respiration work load so drastically in time and amplitude that experiments had to be terminated prior to acquiring necessary data. While the investigator's overall goal was to acquire an instrument that would automatically measure tidal volume, his immediate goal was to develop a low-resistance or resistance-free airflow transducer that would enable him to continue his research while evaluating the data by hand.

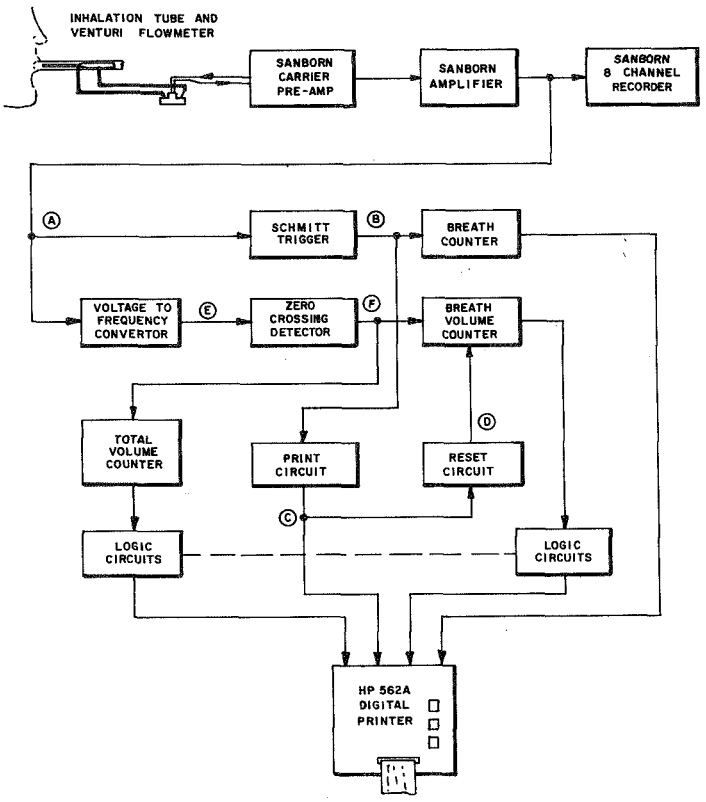


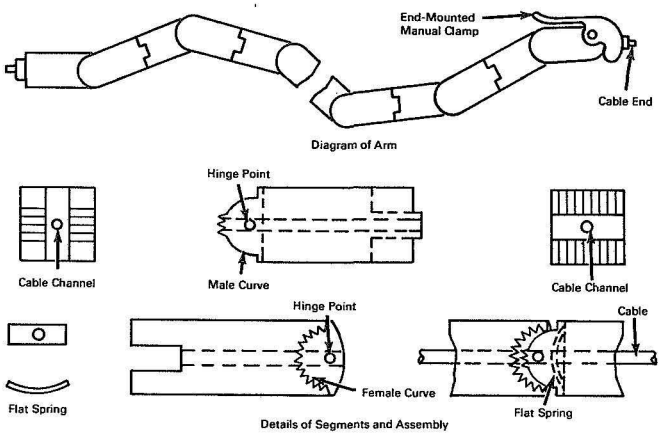
Figure 10. Device Used for Tidal Volume Air Measurement

The team provided a solution for both problems by recovering document N69-13936 from the NASA Data Bank. This paper, entitled *Tidal Volume Air Measurement,* describes an automatic monitor which incorporates a small stainless steel venturi transducer that is obstruction free, thus providing a means for solving the investigator's air resistance problem. The investigator plans to fabricate a prototype from glass, increasing the dimensions proportionately for human use and incorporating a skin diver's snorkle mouthpiece for attachment. A diagram of the transducer assembly is shown in Figure 10 and will be utilized and calibrated in the same manner as described in the paper retrieved from the NASA Data Bank.

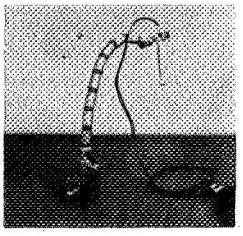
PROBLEM DLM-4 *Doppler Probe Holder and Stand for Use in Chronic Measurement of Fetal Circulation*

Ultrasonic techniques are being used by a Southwest medical school to monitor fetal blood circulation during labor and delivery to determine if abnormal conditions arise during this critical period. Presently a hand-held ultrasonic probe is used to monitor the fetal circulation. For long-term measurements, a means of stabilizing the probe is desirable to (1) reduce artifact generation by inadvertent movement of the probe and (2) relieve the nurse or attendant presently required to hold the probe, for other tasks.

The team accepted the problem and established the need for a holder which was flexible in one mode, rigid in another, but not so rigid as to cause pain during labor. During team interaction with the NASA Langley Research Center, a holder similar to the one required by the investigator was identified and is pictured in Figure 11. Negotiations are presently underway to obtain one of the holders for evaluation. It is described in NASA Tech Brief 70-10465, *Flexible or Rigid Extending Arm.* One motion of a manual clamp makes the universally flexible arm instantly rigid in any configuration. The device is locked by a meshing of gear teeth. Relatively low cable tension locks the teeth. The configurations and specifications of the device very closely approximate the requirements outlined by the problem originator. There is good reason to believe it will prove useful with little or no reengineering requirements.



A. Details of Probe-Holder Segments and Assembly



B. The Completed Doppler Probe-Holder and Stand

Figure 11. NASA-Developed Flexible or Rigid Extending Arm Device Adapted to Serve as a Doppler Probe-Holder

PROBLEM DLM-2 *Temperature Measurement of Brain Core in the Laboratory Rat*

A great deal of pain, limitation of function, and frustration are caused by arthritis and other metabolic diseases. Investigators at a Southwestern medical school are actively studying the causes, neurohumoral mechanisms, and hormone production involved. Small laboratory test animals are used in the studies. The problem originator specifically seeks to gain an understanding of biological mechanisms through monitoring temperatures prevailing in the brain core of laboratory rats. A highly sensitive, miniature temperature transducer is required. Implantation of the device must not significantly disturb the media surrounding the transducer.

The team accepted the problem and, during interaction with investigators at the NASA Manned Spacecraft Center, discovered that technology developed for the biosatellite program appeared to be the solution. Interaction continued with investigators at the UCLA Space Biology Laboratory. Information was obtained concerning the thermistor probes successfully used in the biosatellite program. The specific technology which concerns the project is a 0.069-in.-diameter (0.74 mm) transducer. It is 1 in. in length and uses a miniature microdot connector. The assembly diagram and instructions for assembly and fabrication were forwarded to the investigator. The problem originator has indicated that he intends to evaluate the device used in his experimental research.

PROBLEM BLM-14 *Compound Conduit (Umbilical) for Chronically Surviving Animals*

Investigators engaged in research which has as its overall goal the development of an artificial heart suitable for implantation in humans. At the present stage of the research effort, artificial hearts and left ventricular assist devices are being implanted within animals (calves) and then connected to external pneumatic and hydraulic power sources and various monitoring devices. An important aspect of the research involves developing a suitable means for interconnecting the implanted heart and the relatively large, complex power and monitor components. The present interconnections are subject to kinking, twisting, and being bitten by the chronically surviving animal, thereby interfering with the conduction of the experiment. What is needed is an umbilical which will provide two electric leads, two pneumatic tubes and six hydraulic flexible tubes to power and monitor an artificial heart implanted within an animal. Important features of the umbilical are a quick-disconnect feature and resistance to the excessive friction and high stress conditions brought about by flexing as the chronically surviving experimental animal is permitted long-duration, free ranging about its enclosure.

The team identified two NASA Tech Briefs which contain significant technology that seem pertinent to the solution of important areas of the problem. The documents are: NASA Tech Brief 70-10109, *Improved*

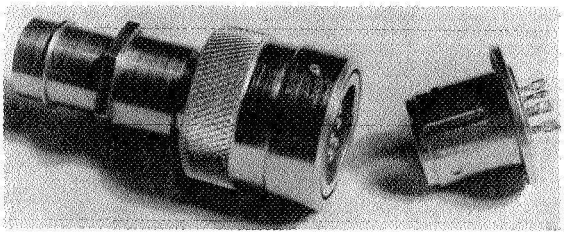


Figure 12. NASA-Developed Quick-Disconnect Electrical Connector

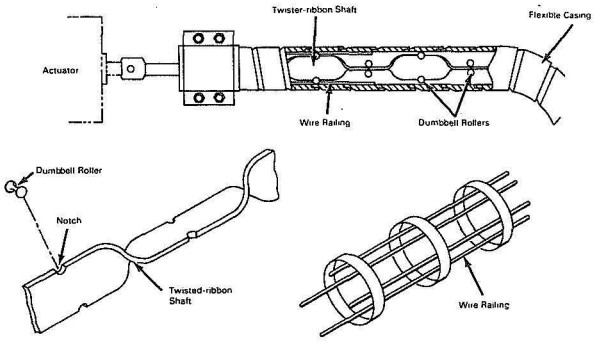


Figure 13. NASA-Developed Improved Mechanical Remote Control Assembly

Quick-Disconnect Electrical Connector, and NASA Tech Brief 70-10144, *Improved Mechanical Remote Control Assembly* (Figs. 12 and 13). The unique quick-disconnect connector would be particularly applicable to the umbilical electric leads and could possibly be modified for the pneumatic and hydraulic leads as well. The innovative approach outlined for the improved construction of mechanical remote control assemblies holds particular promise for overcoming the friction and stress caused by flexing of the umbilical as the experimental animal ranges freely about its enclosure.

PROBLEM DLM-12 *Automated Circulation Control System for a 100,000-Volume Medical Library*

A large Southwestern medical school maintains a 100,000-volume medical library. In the past, circulation has been handled manually. However, continuing increases both in the demand for library services and in the size of the collection are making manual control procedures inadequate. Consequently, library services rendered to the professional staff and medical students are deteriorating. Of particular importance is the inability, under existing manual control procedures, to maintain current, accurate information on items in circulation. Solution of the problem will contribute significantly to improving medical education and research at the medical school. What is needed from NASA technology is a computer-based system for automating circulation control for the library, using available hardware (IBM 1620/2).

The team accepted the problem and in reviewing NASA literature encountered a reference which indicated that the NASA Marshall Space Flight Center and the Army Missile Command jointly had developed an automated, literature processing, handling, and analysis system for the scientific library at Redstone Arsenal, Alabama. Analysis of the system description indicated ready adaptability to computer configurations in other library environments. This satisfied the maximum interchangeability factor specified by the problem originator. The system presently features viable operating programs for patron control of serial routing, book circulating, book ordering, receiving, cataloging, serials ordering, binding, routing, language controlling, and holdings inventorying. Extensive documentation was obtained from the Clearinghouse for Federal Scientific and Technical Information. It sufficiently details the joint NASA/AMC automated library system to permit the problem originator to adapt the system to the school library.

PROBLEM SWC-4 *Information Retrieval System for Clinical Records*

A medium-size Southwestern medical facility having 80,000 admissions annually desires a means to retrieve information from its bank of one-half million clinical records. The hospital particularly desires access to information contained on the records to: augment information related to specific medical treatment, enhance disease prevention, and identify trends in medical treatment. It is also desired that the system permit updating of patient records contained in the data bank as patients return for treatment from time to time. Ultimately, the desire is to perfect techniques for providing guidance in treatment of cryptic diseases by computer analysis. The hospital has sophisticated data processing equipment (IBM Model 360 Computer) but lacks software programs to accomplish the task outlined.

The team accepted the problem and obtained pertinent information from the NASA Manned Spacecraft Center Medical Research and Operations Directorate. They had developed some general computer programs which appeared to meet the requirements outlined in the problem. They were:

- Storage of Medical Records in Retrieval Form
- Retrieval of Medical Data According to Specifications
- Updating of Medical Data Bank

Arrangements were made for the problem originator's representatives to visit the NASA Manned Spacecraft Center (Fig. 14) and discuss possible application of these computer programs to resolve the problem.

PROBLEM HSR-1 *Impression Material for Making Pattern of the Lower Trunk*

An interdisciplinary team at a rehabilitation center in Arkansas is constructing bucket-style contour chairs for use in the care and treatment of spinal cord injury patients, particularly those suffering from quadriplegia (paralysis of all four limbs). Traditionally, such patients have been confined to bed during most of their waking hours. However, by use of specially fabricated contour chairs, the quadriplegic can be permitted to "sit up" for extended periods. To do this, the researchers needed material which would permit them to more accurately, rapidly, and efficiently prepare the impression of the paralyzed patient's body.

The team accepted the problem and conducted a manual and computerized, multiple search of NASA aerospace literature. A response to the problem statement also was received from a NASA research center. Relevant aerospace technology has been located for application to the problem. A method for foam-fabricating a form-fitting helmet liner (Fig. 15) on a pilot's head developed at Wright-Patterson Air Force Base shows great potential as exact-pattern, impression material for the lower trunk. This foam system also may serve another interesting application as a replacement for plaster of paris used as cast material for broken bones.

PROBLEM UFM-5 *Skull Cap Transducer Assembly for Neurological Studies in Cats*

Investigators at a Southwestern medical school are studying cat brain neurons to identify epilepsy cause and effect relationships. They presently apply stainless steel electrodes through a hole previously drilled in the skull. Epileptic neurons in the cat brain dura are then chemically stimulated and the response patterns monitored with an array of electrodes. The researcher has encountered considerable difficulty in maintaining probe stability and electrical continuity. He requires a transducer assembly with the capability to hold electrodes in place and allow for limited depth adjustment.

The team accepted the problem and located a transducer assembly (Fig. 16) during a search conducted for a closely-related problem. The assembly insert can be modified to accept biocompatible carbon electrodes for long-term measurements. Techniques for the required modification are described in NASA publication B69-10087. The entire assembly attaches by two bone screws over the drilled hole in the cat skull.

PROBLEM BLM-11 *On-Line Analysis of Biochemical Samples Collected Automatically from Patients*

A Southwestern medical school is performing research in the biochemical study of laboratory specimens. The samples are manually collected, transported to the laboratory for testing, and laboratory procedures are manually performed. Together these processes represent a time consuming process. Furthermore, significant alterations in concentrations of vital blood substances and urine substances can be missed because collection is too infrequent when the patient's condition rapidly changes; processing delays may produce a late arrival of critical test results needed to help the doctor prescribe a proper treatment; and

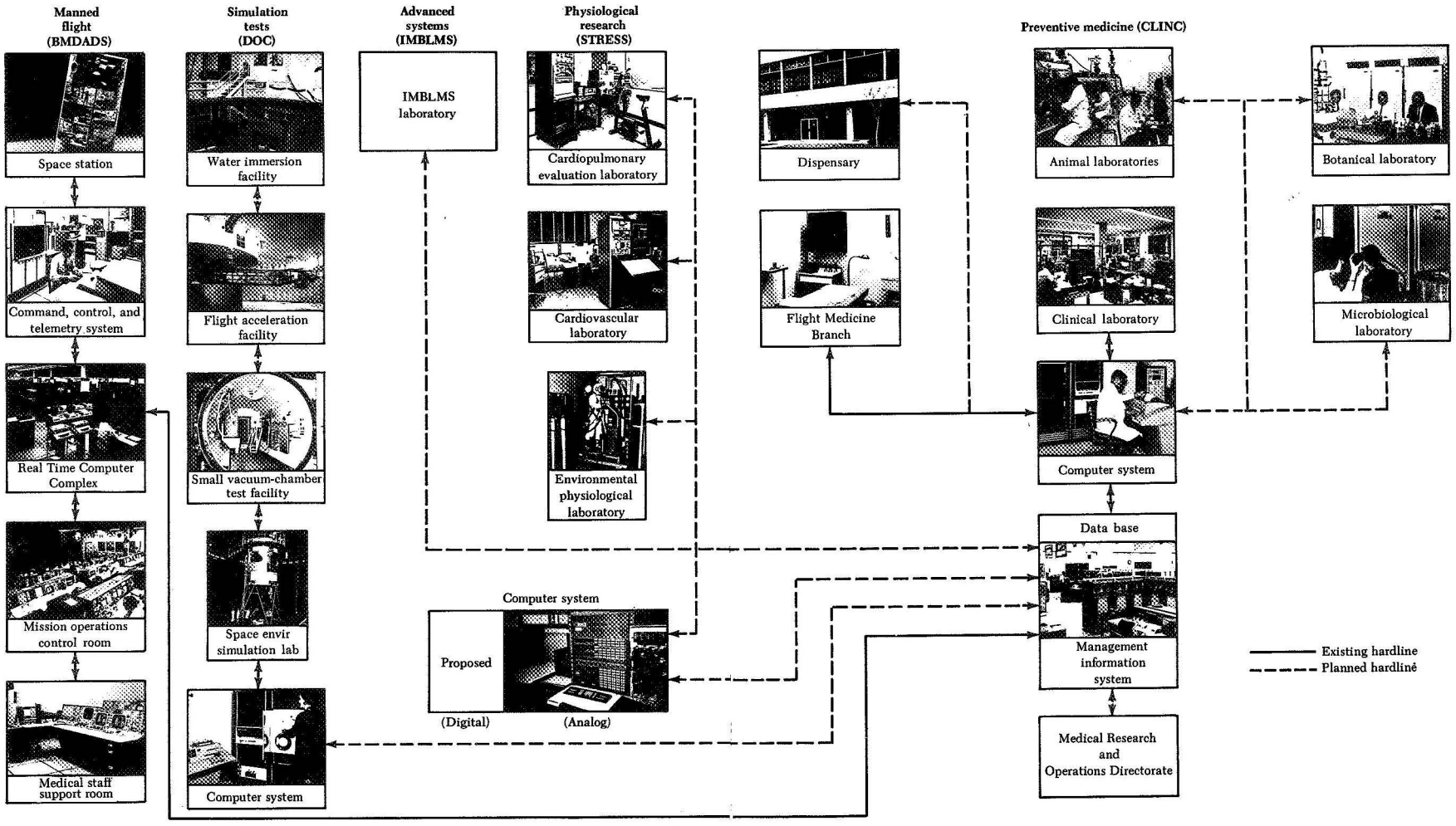
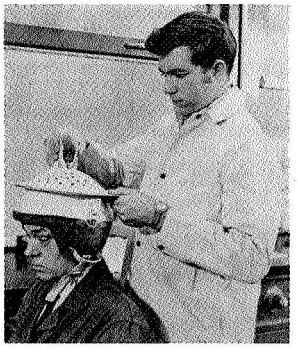


Figure 14. The NASA Manned Spacecraft Center's Information Processing System. Many of the Computer Programs Available Are of Direct Benefit to the Biomedical Community.

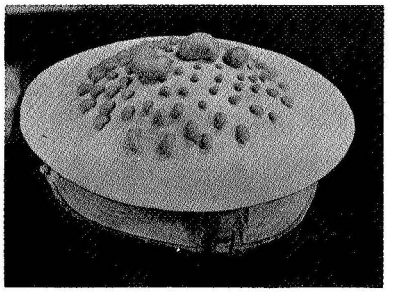
Foam-in-Place Formula

Isocyanate Component	Mondur MR	47.5 gm
	Freon 11	5.25 gm
Polyol Component	Pluracol TP 440	40.0 gm
	Silicone DC 113 or DC 193	0.6 gm
	Freon 11	12.0 gm
	Dibutyl Tri Diacetate	0.52 gm

This formulation develops a reaction temperature of 120° to 130°F and produces a slightly warm feeling on the head, somewhat akin to the temperature of a warm shower. It mixes very readily and reacts reasonably slow.

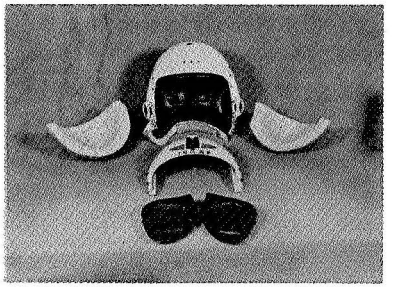


Foam Mixture Poured into Mold



Excess Foam Escaping from Mold

Excess Foam Being Wiped Off of Mold



Helmet Showing Foam-in-Place Liner Assembly

Figure 15. Foam-in-Place, Form-Fitting Technique Developed for Aerospace Application at Wright-Patterson Air Force Base

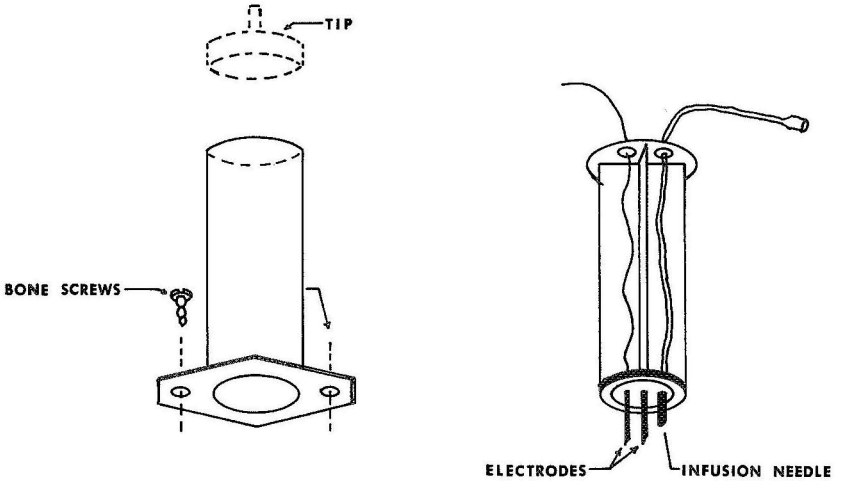


Figure 16. Skull Cap Transducer Assembly Located by Searching the NASA Data Bank

erroneous and misleading biochemical reports sometimes can result from human errors. The problem originator required a system for automated collection of blood and urine specimens with on-line biochemical analysis of the various constituents. The system must be able to accept quantitative test procedures for sodium, potassium, carbon dioxide, glucose, urea nitrogen, serum glutamic oxalacetic transaminase, and serum glutamic pyruvic transaminase.

The team accepted the problem and made a search of the NASA Data Bank for appropriate information. Description of NASA-developed technology was obtained from the data search to completely fill the requirements of the problem and is pictured in Figure 17. This complete information was furnished to the problem originator who is using it to prepare an application for additional funds from the National Institute of Health to develop the necessary on-line biochemical monitoring.

PROBLEM BLM-11a *On-Line Analysis of Biochemical Samples Collected Automatically from Patients*

The problem originator in continuation of the preceding problem, requested additional information concerning an automated on-line, urine biochemical analysis monitoring system.

The team procured a detailed report of a highly miniaturized urine analysis instrument (Fig. 18) developed by the NASA Jet Propulsion Laboratories for the Biosatellite III program. A complete description was furnished to the problem originator, and he has included the information in his request for further funding in this area.

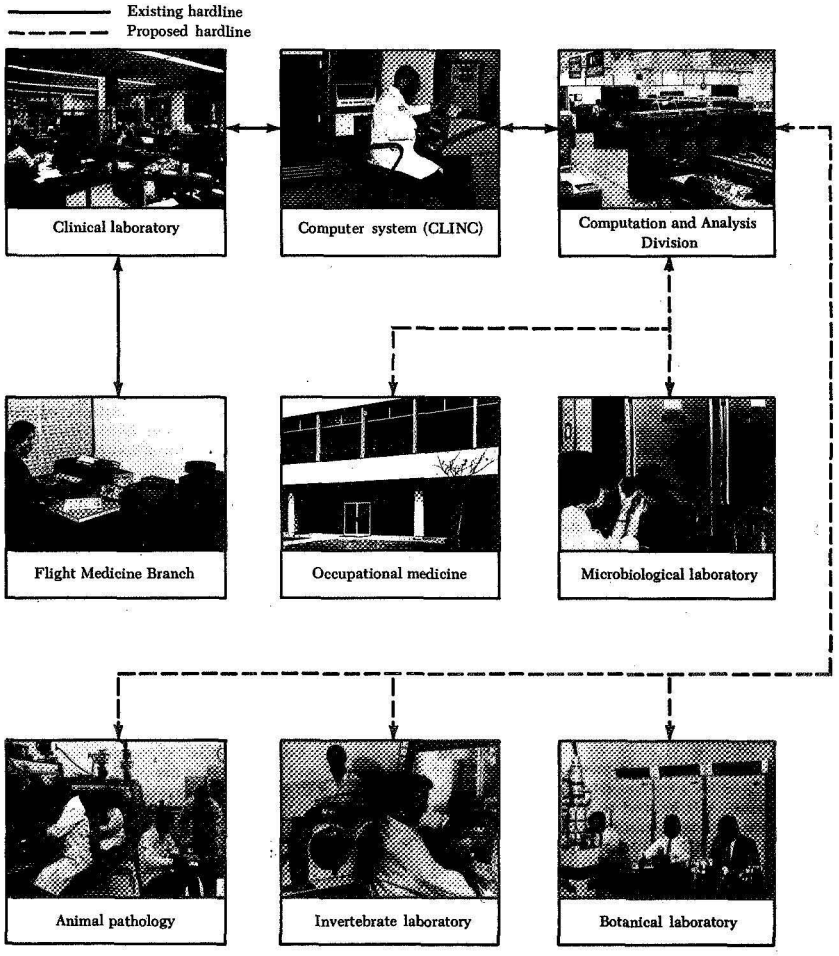
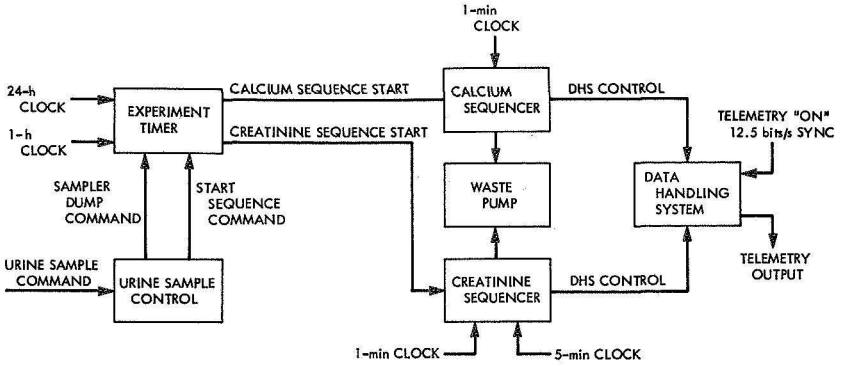


Figure 17. The Manned Spacecraft Center–Clinical Laboratory Computer System



Functional block diagram

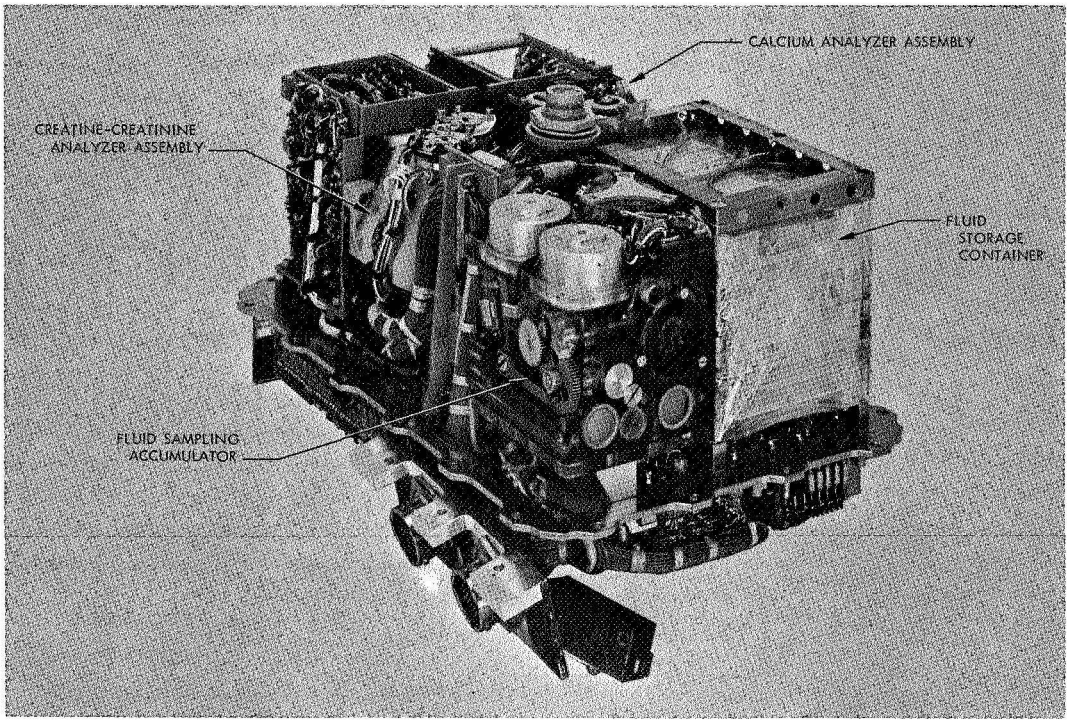


Figure 18. Miniaturized Urine Analysis Instrument Developed by NASA for Biosatellite Use

PROBLEM BLM-13 *Nonthrombogenic Material for Use as a Blood Interface*

A Southwestern medical school is conducting research in the development of artificial organs. A serious problem has resulted from the nonavailability of suitable biochemical material which can serve as a blood interface. Most available materials must be rejected because they are thrombogenic and therefore cause blood clotting in the blood stream. Wholly compatible material also must be non-carcinogenic. Its physical characteristics must permit processing into suitable configurations for surgical implants. Nonavailability of suitable biomedical material poses a serious delay in artificial organ research. Work has been advanced in the area of polymer surfaces and heparinization of various materials. This may or may not produce a completely reliable nonthrombogenic material. The

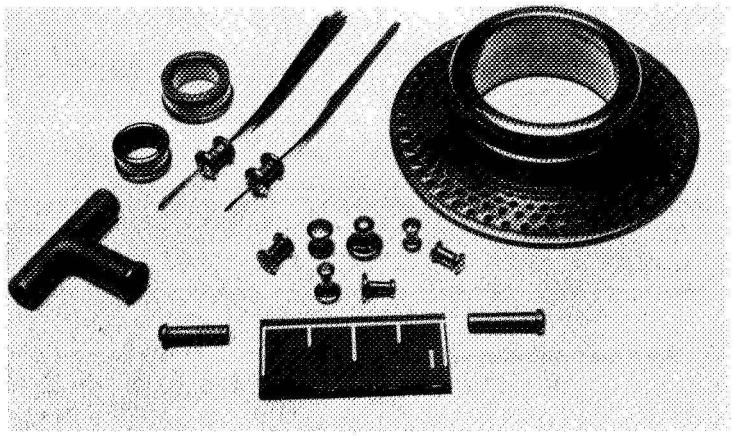


Figure 19. Various Biocarbon Implants (Shown are a percutaneous arterial fistula; percutaneous myoelectrodes; transcutaneous window; stoma for the ileum; and bone pins.)

treatments applied to a material to render it nonthrombogenic, in some instances, have produced a surface which is highly toxic to tissue cells. All these factors must be considered in selecting a suitable interface material. It was thought that the NASA work being done with biocarbon materials might offer a solution.

After accepting the problem, the team disseminated a description of the problem to the various NASA research centers. As a result, information was provided by Marshall Spaceflight Center concerning existing NASA technology in the area, as well as a source (biocarbon$_{TM}$) for samples. A number of samples were obtained (plugs, filaments, woven fabric, etc., Fig. 19) and forwarded to the investigator for long-term evaluation.

PROBLEM SWC-1 *Improved Techniques for Taking EEG in Infants and Small Children*

Investigators at a Southwestern medical facility are perfecting a technique for using the EEG to test hearing of small children. Today thousands of children classified as mentally retarded are believed to be suffering not from mental retardation, but rather from hearing difficulties which have cut them off from the auditory interchange and the environmental stimuli, which is needed to develop their intellect. The investigators are convinced that if they can identify hearing defects early in infancy and initiate appropriate remedial measures they can prevent many youngsters from becoming functional metal retardates. An instrumented helmet is needed with EEG electrodes in place; such a helmet, particularly if equipped with earphones for administering the auditory signal, would substantially assist in identifying hearing defects in young children who cannot verbally communicate information regarding whether they hear an auditory stimuli and to what degree they hear it.

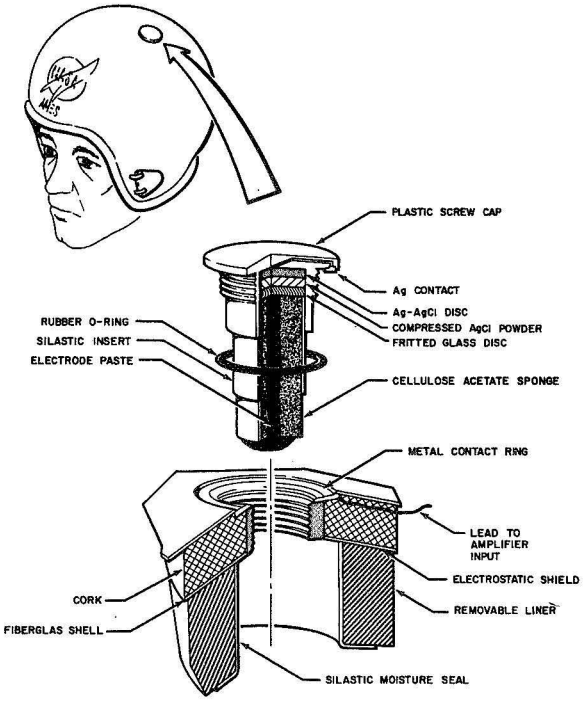


Figure 20. NASA-Developed EEG Helmet Suitable for Adaptation as an Audiometric Screening Device

Search of the NASA Data Bank revealed two instances of aerospace technology which were appropriate for solution of the problem: NASA Tech Brief 66-10536, which describes a special helmet with built-in electrodes (Fig. 20) and USAF publication ARL-TR-69-17-6571, which describes a special technique for equipping a helmet with earphones. The team is currently considering the problem as a candidate for applications engineering.

PROBLEM SNM-5 *Implantable Telemetry System for ECG*

Researchers at a Southwestern medical school expressed a need for a small, implantable

telemetry system to continuously transmit electrocardiographic data from experimental animals surviving cardiac transplants, to monitor the onset of rejection phenomena. The system had to be small, be biocompatible, and have a useful life of about 60 days. The system also had to have an effective range of about 20 ft.

The team accepted the problem and conducted a search of the NASA Data Bank for a possible solution. One document retrieved contained circuitry information for the subminiature, remote, biotelemetry, physiological investigations system shown in Figure 21. Detailed information describing the system was forwarded to the investigator. A replica of the NASA unit has been fabricated which is suitable for long-term implantation in primates subjected to heart transplants (see Fig. 22).

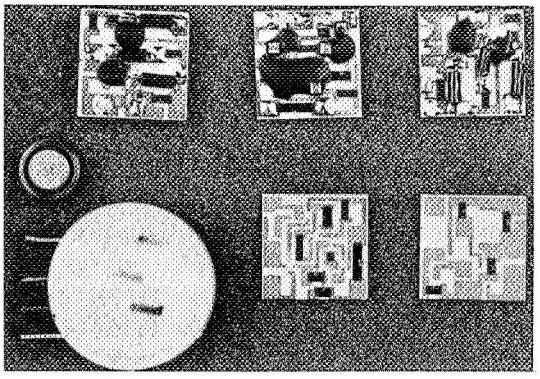


Figure 21. NASA-Developed Subminiature Biotelemetry Unit Transmit Electrocardiographic Data

Figure 22. NASA-Developed Subminiature Biotelemetry Unit Being Implanted in an Experimental Animal

PROBLEM RNV-14 *Materials for Prevention of New Decubitus Ulcers*

Decubitus ulcers tend to develop over the bony areas of the body of spinal cord injury patients who experience sensory loss. The ulcers require from 2 weeks to 4 months for healing. Some require surgery to effect closure. The average estimated cost of caring for a decubitus ulcer is about $15,000. Researchers at a West Coast rehabilitation center are seeking help in identifying a type of cushion material for the prevention of the decubitus ulcers. The cushion successfully prevents development of the ulcers by eliminating high pressure points through redistribution of the pressures on the patient's body.

The team accepted the problem and arranged for interaction with the various NASA research centers. Two types of cushion material were identified as holding promise for reducing the incidence of decubitus ulcers (see Figs. 23 and 24). Long-term evaluations are currently in progress at several research institutions.

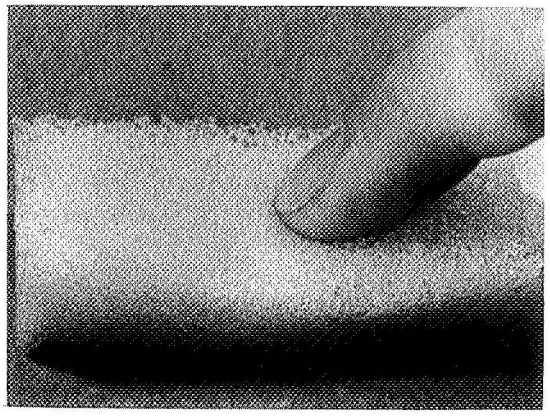


Figure 23. Polymethane Foam Developed by NASA for Space Vehicle Seat Cushions

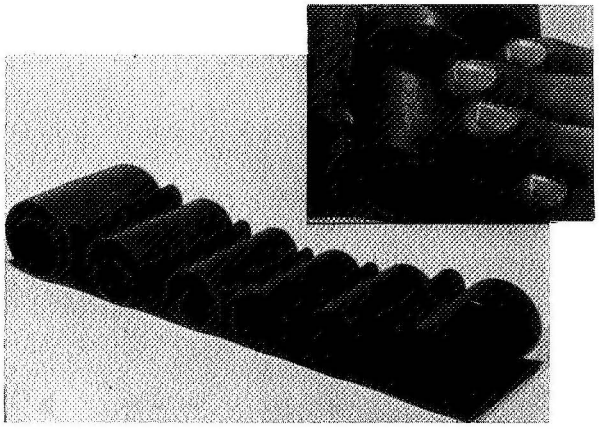


Figure 24. Special Slit Tube Fiber Glass Cushion Material Developed by NASA for Space Vehicle Application

PROBLEM DVM-4 *Automatic Atraumatic Blood Pressure Measurement*

An investigator at a West Coast medical school needs an atraumatic means to measure blood pressure of humans undergoing a variety of tests. The means must be capable of automatic operation and be relatively immune to acoustical or motion artifacts.

The team accepted the problem and was successful in identifying a relevant NASA-technology device. It is an ultrasonic doppler, blood pressure apparatus (Fig. 25). Information concerning the specifications was furnished to the problem originator who is in the process of fabricating a working model for use in evaluation against the requirements of his problem area.

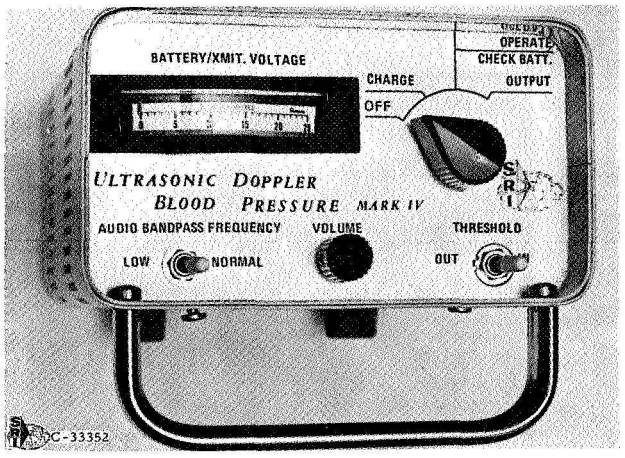


Figure 25. Front Panel NASA-Funded Ultrasonic Doppler Blood Pressure Measuring Instrument

PROBLEM CAP-1 *Apparatus for Telemetering GSR in Natural Social Settings*

The researcher is conducting experiments to determine the feasibility of employing instrumentation for monitoring behavioral phenomena. As part of this research, the GSR (Galvanic Skin Response) is being telemetered from adolescent delinquents as they interact in their natural social settings, e.g., home, school, and hangout. Dry electrodes applied to the plantar region (inner aspect of the instep) are used to acquire the GSR, with the signal being conducted from the foot via a connecting link (concealed in the trouser leg) to a transmitter at some convenient place on the delinquent's person. The system involves a remote, two-way, coded audio communications link which functions only with marginal success. Difficulties in this setup involve motion artifacts associated with the electrodes, excessive noise, and poor acceptance of the remote transmission apparatus by the experimental subjects due to its bulk.

The investigator needed a small, reliable apparatus which will acquire and transmit the galvanic skin response. The circuitry must feature high common mode injection and be compatible with an acceptable type of GSR electrode, acceptability being defined in this context as: long-term use (24 hr or longer); free from motion artifact; and small enough to be applied comfortably to the individual's instep.

The team accepted the problem and conducted a search of the NASA Data Bank. NASA Tech Briefs 66-10624 and SP 5054 produced information described in a NASA miniature biopotential telemetry system. This information was furnished to the problem originator (Fig. 26). Minor modifications were

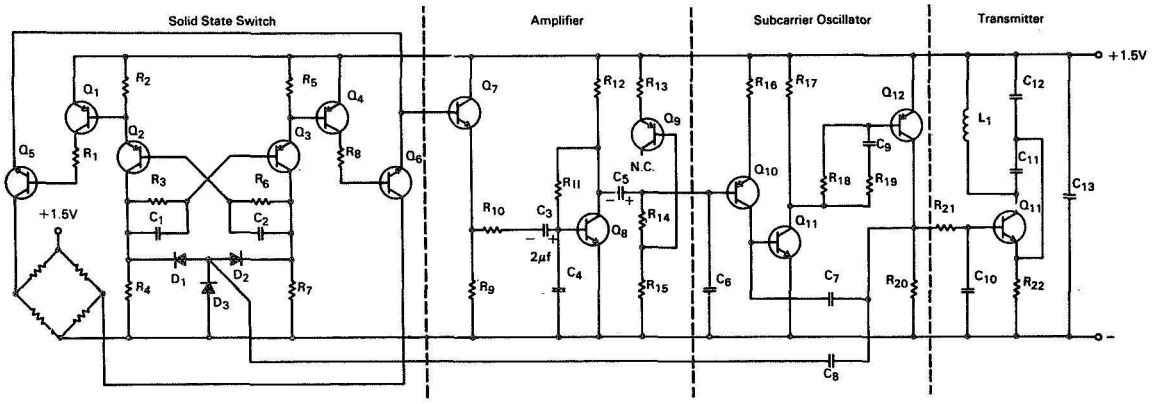


Figure 26. NASA-Developed Telemetry System

suggested to meet the investigator's requirements. After modifications have been incorporated, the device will be evaluated for effectiveness in the problem area.

PROBLEM UTM-7 *Chronic Electrode Implantation Techniques for Artificial Eye Research*

Investigators at a Southwestern medical school are extensively researching development of an artificial eye. Instrumentation and techniques are being perfected to wire an electronic (TV) camera directly into the visual area of the brian. Much basic research must be undertaken before this interface can be accomplished. The various neural and electrical parameters must be clearly defined. The investigators currently desire to define various central nervous system parameters and express them in electrical terms. This is a necessary first step establishing requirements for the electronic camera interfacing with the brain. The investigators must implant miniature electrodes into various, central nervous system locations to define the parameters. The optic nerve is one such location. The precise nature and function of the body's visual mechanisms can be adequately delineated only by such methodology. The investigators desire biocompatible electrode materials from aerospace technology which are suitable for transplant within the central nervous system. They also require related techniques for fabrication and implantation of subminiature electrodes.

The team accepted the problem and surveyed the NASA Data Bank. NASA Tech Brief 69-10087 was retrieved as a possible source of assistance. It describes technology associated with carbon myoelectric probes. They are implanted in muscle tissue to pick up or receive electrical impulses in the picowatts to nanowatts range. The apparent galvanic inertness of biocarbons suggests the materials may be compatible with specifications of the problem. The material can be fabricated as filaments or small diameter rods. The investigators presently are continuing their evaluation of these NASA-developed biocarbons.

PROBLEM SNM-4 *Improved Techniques for Measuring Skin Thickness*

In the biomedical sciences, the measurement of body fat and skin thickness is performed indirectly by measuring skin fold thickness over body fat tissue with calipers. Measurements of skin thickness by this manner lack precision needed for the reproduction of reliable research data. Accordingly, researchers at a Southwestern medical school are seeking a new method for making accurate and precise skin thickness measurements which is compatible with procedures of obtaining skin thickness measurements as a function of time. The desired instrument must be portable and designed to be useful in field research under changing environmental conditions, as well as in hospital environments.

The team accepted the problem and searched the NASA Data Bank for information. A U.S. Air Force-developed ultrasonic device was described. Consultation with the investigator indicates this device will be potentially useful when it is applied to the problem area. Evaluation continues.

PROBLEM RNV-28 *Accelerometer for Human Motion Studies*

Kinesiology investigators at a West Coast rehabilitation center are performing human motion studies on patients who have difficulty in walking. The studies are used for planning corrective surgery or for improving bracing techniques. The investigator believes it may be possible to evaluate and diagnose orthopedic cases in an on-line manner if proper techniques of data acquisition and analysis were available. This could facilitate development of courses of treatment. The investigators requested team assistance in locating small, light, and rugged triaxial accelerometers for collecting required motion data.

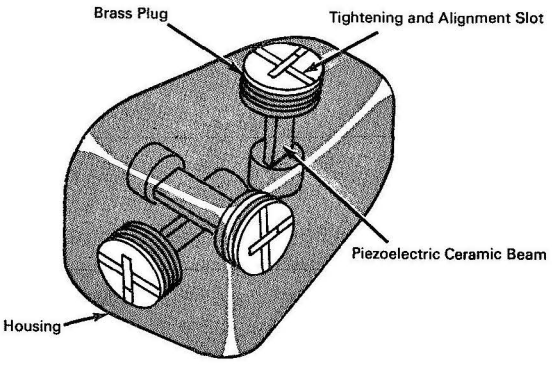


Figure 27. NASA-Developed Triaxial Accelerometer Suggested for Use in Human Motion Studies

The team accepted the problem and established the availability of the accelerometers (Fig. 27) via a computer search plus interaction with investigators at the NASA Ames Research Center. The

acquired information was provided to the researcher together with a commercial source of supply. The investigator is presently evaluating the information for application to the problem area.

PROBLEM RNV-13 *Improved Laryngoscope for Use in Disabled Children*

Children having rheumatoid arthritis are frequently subject to multiple operations to correct the condition. It is not always feasible to insert a breathing tube when the affected area is in the jaw. This usually requires performance of a tracheotomy, since conventional breathing tubes cannot be inserted in the throat because of jaw rigidity, small passages, and short bending radii. The necessity for the tracheotomy could be avoided if a highly flexible, highly maneuverable laryngoscope were available to maneuver a breathing tube into place. The investigator sought team assistance in obtaining technology for that purpose.

The team accepted the problem and searched for NASA inspection devices used in surveying highly inaccessible space capsule locations. A computerized search of the NASA Data Bank failed to retrieve directly relatable NASA technology. Documentation did identify a commercially available device. This information was provided to the investigator who was able to negotiate with the commercial product source for development of a custom instrument for his particular needs. Evaluation of factors in this problem area continues.

PROBLEM NWR-5 *Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section*

An investigator at a Northwestern medical school requires a means for predicting tissue heating produced by applied diathermy or ultrasound. Fat, muscle, and bone layers have cross sections which do not match classical cylinder or rectangular shapes. Temperature rise in these various layers is determined by heat dissipation and transfer. The investigator believes numerical techniques can be used to solve these problems. This will allow greater flexibility regarding boundaries. It could easily be programmed for computer solution of heat dissipation problems.

The team accepted the problem and initiated interaction with NASA research centers. Computer programs available at the NASA Lewis Research Center at its Plum Brook Station appeared to be adaptable to this area. Information was furnished to the investigator and he is evaluating feasibility of application to his problem area.

PROBLEM DLM-6 *Measurement of Respiration Parameters of Cardiovascular Patients*

To determine the severity of cardiovascular disorders among patients suffering from these diseases, it is important to measure related physiological parameters. One of the functional parameters is respiration. An investigator at a Southwestern medical school is seeking effective ways to measure (1) respiratory rate primarily, and (2) tidal volume. Since treadmill and bicycle ergometer testing are involved, the sensors used must be of a low resistance type and must not interfere with the patient's activity. The investigator asked the team to determine if NASA technology was available for solving this important problem.

The team accepted the problem and searched the NASA Data Bank. Document 68-10438 was retrieved. It described a nosepiece respiration monitor (Fig. 28) which had been developed by NASA. The complete information was provided to the investigator. He is currently evaluating applicability of the device to his requirements.

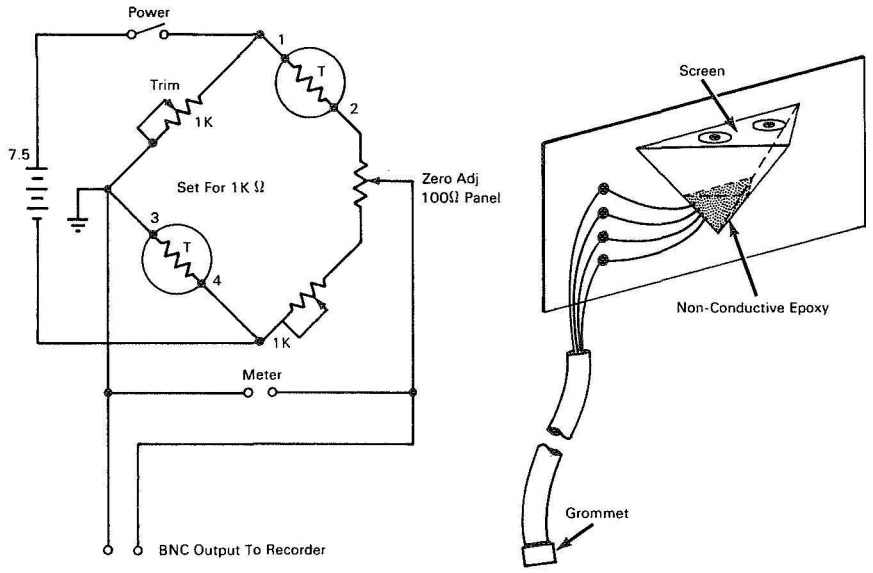


Figure 28. NASA-Developed Nosepiece Respiration Monitor Proposed for Use in Respiration Rate Monitoring of Cardiovascular Patients Undergoing Exercise

PERIPHERAL PROGRAM BENEFITS

Considerable peripheral benefits are possible from the NASA technology utilization program. They include but are not necessarily limited to the following:

(1) Manufacturers have become conscious of the many potential commercial applications of aerospace technology as the teams continue to identify important biomedical problems during their interaction with medical researchers. Such interest is evidenced by the increasing number of inquiries from industry regarding team activities.

(2) The Biomedical Application Team concept provides a vehicle for recognizing individual researchers within the NASA community who conceive of ways in which the technology they develop can help solve significant biomedical problems. Such recognition, if promoted, could encourage NASA scientists to share their ideas in attacking other important problems facing the biomedical community, particularly for those problems requiring NASA's specialized facilities and extensive interdisciplinary expertise for solution. This carries with it the potential for enhancing the social significance of the space effort.

(3) The information retrieved from team searches of the NASA Data Bank frequently makes available combinations of concepts and technology which are not ordinarily available to biomedical researchers. This is particularly the case since the data bank includes a significant portion of foreign technology documentation. The comprehensiveness of the information retrieval service afforded by the team can, in many cases, help stimulate solution of important problems impeding progress in medicine.

III. SUMMARY OF PROBLEM ACTIVITY UNDERTAKEN DURING THE REPORT PERIOD

PROJECT ACTIVITY SUMMARY

The following is a summary of project activity undertaken by the team during the period February 1969 to August 1970. Additional information concerning project activity is attached as Appendix A:

New Problems Accepted	218
Problems Rejected	13
Problems Inactivated	90
Problems Reactivated	9
Total Problems Currently Active	178
Preliminary Problem Statements Prepared	129
Problem Statements Submitted for Review	68
Problem Statements Disseminated	28
Responses to Problem Statements	68
RDC Computer Searches Initiated	52
Other Searches Initiated	120
Search Evaluations	58
Potential Transfers Claimed	22
Transfers Claimed	11

HEALTH AREA IMPACT

The health area impact categories for the teams' active problems is shown in the following table.

DESCRIPTION OF CURRENTLY ACTIVE PROBLEMS

A description of currently active problems categorized by health areas is attached as Appendix B.

ATTENDANCE OF TEAM MEMBERS AT MEETINGS AND SYMPOSIA

Mr. C. J. Laenger attended the National Institutes of Health, National Heart Institute, Artificial Heart Program Conference, 11-13 June 1969, Washington, D.C.

Dr. Ray Ware attended the Arizona Hospital Association Meeting at Phoenix, Arizona, 2-3 October 1969. Dr. Ware's function at the meeting was to acquaint the attendees with the Biomedical Applications Program.

TABLE 1. IMPACT AREAS OF ACTIVE PROBLEMS

Health Area Impact Categories	Analytic Inst. Systems	System Components (Equip.)	Computer Programs	Prosthetic Devices	Materials/ Chemicals	Therapeutic Equipment	Other	Total
Communicable Disease								
Multiphasic Health Screening	1	1			1		1	4
Rehabilitation Medicine	2	5	1	1	4		1	14
Artificial Organs	1							1
Organ Assist Devices								
Mental Health	1	3					1	5
Heart Disease Treatment	4	12	1		1	2		20
Cancer Detection	1	2						3
Ecology								
Health Care Cost Reduction	1	1	1					3
Remote Health Services								
Medical Personnel								
Kidney Disease		1			1			2
Infant Mortality		5						5
Respiratory Disease	2	1						3
Surgical Procedures	1	3	1		1		1	7
Dental Medicine	1							1
Basic Medical Research	11	6	2		1		3	23
Other	11	2	2		2			17

IV. INSTITUTIONS CURRENTLY UTILIZING SERVICES OF THE SOUTHWEST RESEARCH INSTITUTE BIOMEDICAL APPLICATIONS TEAM

Location of Institutions Using the Services of the SwRI Biomedical Applications Team.

Baylor University Medical School
Houston, Texas

The Claremont Colleges
Claremont, California

Gallup Indian Medical Center
Gallup, New Mexico

Georgia Institute of Technology
Atlanta, Georgia

Hot Springs Rehabilitation Center
Little Rock, Arkansas

Loma Linda Medical Center
Loma Linda, California

Los Angeles County Hospital
Los Angeles, California

Northwest Institute for Rehabilitation
Seattle, Washington

Palo Alto Medical Research Foundation
Palo Alto, California

Rancho Los Amigos Hospital
Downey, California

St. Josephs Hospital
Phoenix, Arizona

Scott and White Hospital & Clinic
Temple, Texas

Stanford University School of Medicine
Stanford, California

Texas Institute for Rehabilitation and Research
Houston, Texas

University of Alabama Medical School
Birmingham, Alabama

University of Arizona Medical School
Tucson, Arizona

University of California Medical School
Davis, California

University of Florida
Gainesville, Florida

University of Florida Medical School
Gainesville, Florida

University of Oklahoma Medical School
Oklahoma City, Oklahoma

University of Southern California Medical School
Los Angeles, California

University of Texas Medical Branch
Galveston, Texas

University of Texas Medical School
San Antonio, Texas

University of Texas Southwestern Medical School
Dallas, Texas

University of Utah Medical School
Salt Lake City, Utah

University of Washington Medical School
Seattle, Washington

Veterans Administration Hospital
Albuquerque, New Mexico

Veterans Administration Hopsital
Bay Pines, Florida

Veterans Administration Hospital
Birmingham, Alabama

Veterans Administration Hospital
Dallas, Texas

Veterans Administration Hospital
Gainesville, Florida

Veterans Administration Southern Research Support Center Hospital
Little Rock, Arkansas

Veterans Administration Hospital
Long Beach, California

Veterans Administration Hospital
Sepulveda, California

Veterans Administration Hospital
Shreveport, Louisiana

Veterans Administration Hospital
Temple, Texas

Western Research Support Center
Sepulveda, California

Wilford Hall Hospital
Lackland AF Base, Texas

V. APPLICATION ENGINEERING ACTIVITY

The following problems have been accepted for consideration as candidates for applications engineering. Under this program, selected items of NASA technology are subjected to modifications designed to render them more appropriate for a particular application:

Problem GLM-5 *Intracranial Pressure Measurement*

Chronic intracranial pressures often produce swelling of central nervous system tissue following head injuries. Brain tissue expands and reduces perfusing blood flow. Inadequate oxygenation produces cell death. Drugs can be used to draw fluid out of the brain and return it to the circulating blood, effectively reducing fluid pressures in intracranial tissues. A quantitative guide is needed to indicate when the drug should be given and what the magnitude of its effect has been. A tube may be implanted to cannulate the patient's cerebral ventricles, but this offers a potential route of infection. Pressure readings in this instance alter according to the active or possible relocation movement of the patient with regard to the transducer. The researcher was using a Scientific Advances strain gauge. The device registers an undesirable wedge pressure when it is slipped between the brain and the membrane covering the brain. It is markedly influenced by temperature and has no temperature compensation. A Schaevitz-Bytrex two-arm strain gauge inserted into a plastic screw is used for the same purpose by another group of researchers. They have reported no temperature data nor fidelity. Each of the transducers costs $500 or more. Several transducers are needed and they should have identical characteristics with appropriate temperature compensation. The device must be moisture proof and be reliable for several weeks of use.

The team identified a miniature electromechanical tunnel diode transducer during a search of NASA literature. The device is simple, very small in size (less than 1 mm), has good resolution (0.3 mm Hg for a 1000-Hz bandwidth) and wide dynamic range (60 dB), has generally high-temperature sensitivity (equivalent to 25 mm Hg/°C) but is readily reduced by conventional compensation techniques to the equivalent of about 1 mm Hg/°C or better. The present design is particularly attractive for biomedical applications which require special configurations and circuitry. Although it generally possesses desirable features, they are not specific for the stated problem. Applications engineering is required to develop a fully adequate device. Following are specifications for the needed device:

> The transducer should have an outside diameter of 0.050 in. or less; pressure range of 40 to 200 mm Hg; linear accuracy of approximately ±5 mm Hg at 100 to 200 mm Hg; withstand chronic exposure to blood and saline solution; be mounted on a square, flat tab with suture holes permitting suturing to the outside of small blood vessel walls; with associated electronics package diagram and parts list to be furnished; and for use at present on an experimental animal (rat).

PROBLEM SRS-8A *Acquisition and Telemetry of Heart Rate, Blood Pressure, and Blood Flow in Free-Ranging Dogs*

In this problem, a means is required to telemeter cardiovascular parameters of pulse rate and systolic and diastolic pressures from the pointer bird dog. Electrocardiograms from two strains of dogs are being obtained. There appear to be differences between the two categories which are observable by human visual inspection. This visible difference should be quantified by a suitable technique. Several standard techniques are available for quantifying and comparing time series signals. The spectral analysis, auto and cross correlation techniques are the most common. They may not uncover quantitative and fairly simple information which is related to the geometric properties of a two-dimensional signal such as the ECG shape on a strip-chart recorder. New concepts of signal categorization and similar types of categorization problems are desired as possible solutions to this problem area. A digital computer is available for signal processing, and computer programs for this purpose are of secondary interest in solution of the problem. The objective of the problem is an understanding of the differences between one "nervous" strain of the bird dog and a so-called "normal" strain.

It is felt that the knowledge and understanding of the parameters of difference between the normal and nervous strains of dogs will be useful in understanding and treating *mental illnesses in humans.*

A search of literature and NASA Research Center's cooperative effort disclosed a Technical Note authored by W. Rindner, A. Garfein, E. Pittelli, and A. Iannini, entitled *A Miniature Electromechanical Tunnel Diode Transducer.* The device was developed as a wireless telemetering package by the Electronics Research Center, Cambridge, Massachusetts, for the NASA-Ames Research Center.

The investigator requested that the NASA-developed device be adapted for use on a free-ranging dog. It is expected that the device will overcome the previously encountered problems of noise and measurement error.

PROBLEM RNV-14 *Materials for Prevention of New Decubitus Ulcers*

Pressure sores develop over the bony sitting surfaces of spinal cord injury patients with sensory loss while they are sitting in a wheelchair. There are many different cushions which are manufactured and currently claim to eliminate development of these decubitus ulcers. The primary purpose of the cushion material is to eliminate high-pressure points through redistribution of body pressures. The material has to be laterally stable and permit the patient to slightly shift his weight without having the material react by dumping him or pushing him sideways. This has been the problem experienced with water cushions. The material should be somewhat compressible. Although water cushions, molded foam, air cushions, and silicon gel cushions (Stryker Company) have been experimentally tested, none of them have been completely satisfactory. The needed material must be light and have properties generally described as viscoelastic. The response of the material to changes of load must have a small time lag of indeterminate exactness. Pressures throughout the material must be nearly constant and be somewhat compressible. A gel of some type is considered to be a likely choice of material.

Team interaction with investigators at Ames Research Center identified a polymethane foam developed for space vehicle seat cushions and a special slit tube fiber glass cushion material developed for space vehicle applications.

The team proposed that the polymethane foam and/or the slit tube fiber glass materials be adapted for use as cushion material for wheelchairs and bed pads, so that their utility as a means for preventing formation of new decubitus ulcers on patients with spinal cord injuries can be evaluated.

Prevention of new decubitus ulcers for patients with spinal cord injuries is essential. The cost of medically treating decubitus ulcers is significant and the overall patient care will be markedly improved. Prevention of new decubitus ulcers will contribute to control of infections within hospitals and treatment centers. For these reasons, the team arranged for the fabrication and evaluation of cushions and bed pads at several locations. Due to the nature of the problem, the evaluation must be long term in nature.

PROBLEM BLM-14 *Compound Conduit (Umbilical) for Chronically Surviving Animals*

The investigator is engaged in research which has as its overall goal the development of an artificial heart suitable for implantation in humans. At the present stage of the research effort, artificial hearts and left ventricular assist devices are being implanted within animals (calves) and then connected to external pneumatic and hydraulic power sources and various monitoring devices. An important aspect of the research involves developing a suitable means for interconnecting the implanted heart and the relatively large, complex power and monitor components. The present interconnections are subject to kinking, twisting, and being bitten by the chronically surviving animal, thereby interfering with conduct of the experiment. What is needed is an umbilical which will provide two electric leads, two pneumatic tubes, and six hydraulic flexible tubes to power and monitor an artificial heart implanted within an animal. Important features of the umbilical are a quick-disconnect feature and resistance to the excessive friction and high stress conditions brought about by flexing as the chronically surviving experimental animal is permitted long-duration, free ranging about its enclosure.

The investigator felt that NASA possessed technology in the area of quick-disconnect connectors and special construction techniques used for remote control assemblies which would apply to the problem.

Solution of the problem will help advance research in artificial heart development, thus accelerating the time when such devices are available for implantation in humans. The team identified two recently released NASA Tech Briefs which contain significant technology that seem pertinent to solution of a major portion of the problem. The documents are: NASA Tech Brief 70-10109, "Improved Quick-Disconnect Electrical Connector," and NASA Tech Brief 70-10144, "Improved Mechanical Remote Control Assembly." The unique quick-disconnect connector would be particularly applicable to the umbilical electric leads and could possibly be modified for the pneumatic and hydraulic leads as well. The innovative approach outlined for the improved construction of mechanical remote control assemblies holds particular promise for overcoming the friction and stress caused by flexing of the umbilical as the experimental animal ranges about its enclosure. The quick-disconnect connector in its present configuration is relevant to the electric leads of the described umbilical. However, it is possible that the connector can also be adapted to the pneumatic and hydraulic tubes, to provide all leads with the desired quick-disconnect capability. The construction technique concept described in Tech Brief 70-10144, while devoted to fabrication of a force-transmitting shaft, could probably be used to good advantage for constructing the twist-kink resistant leads and lines which form the interconnection between the implanted artificial heart and the monitor/control setup. It is envisioned that a hole would be placed at each "twist" of the twisted ribbon shaft to provide a route for the leads and lines.

A quick-disconnect feature is desired on both ends of the umbilical components. One of the electric leads will be an ECG lead. The length of the required umbilical is approximately 5 m, with the thickness being limited to about 1 cm by the space between the animal's ribs. The umbilical should provide for swivel action to prevent kinking as the chronically surviving animal moves around. The two pneumatic (CO_2 pressure/vacuum) lines will run respectively at +5 psig and −2 psig, with a pulsating flow approximating 0.1 ℓ/sec. The six hydrostatic coupling columns do not involve an appreciable flow.

PROBLEM SWC-1 *Improved Techniques for Taking EEG in Infants and Small Children*

The investigator is perfecting a technique for using the EEG to test hearing of small children. Today thousands of children classified as mentally retarded are believed to be suffering not from mental retardation, but rather from hearing difficulties which have cut them off from auditory interchanges with environment. Such interchanges are needed to develop their intellect. The investigator is convinced that, if hearing defects can be identified early in infancy and appropriate remedial measures initiated (e.g., hearing aids), many youngsters can be prevented from becoming functional mental retardates. The investigator has developed instrumentation to provide averaged EEG signals during periods of auditory stimulation, which quite effectively reflect whether a child hears when such stimuli is administered. The greatest difficulty is in securely affixing the EEG electrodes to the infant's or young child's head. They tend to tug at the electrodes and frequently yank them off, disrupting the screening procedure. What is needed is an instrumented helmet, with EEG electrodes in place. A helmet, particularly if equipped with earphones for administering the auditory signal, would substantially assist in identifying hearing defects in young children who cannot verbally communicate information regarding whether–and to what degree–they hear an auditory stimulus.

NASA has developed a helmet system for broadcasting electroencephalograms of the wearer. The unique electrodes involved, if incorporated into an audio helmet fitting infants and small children, would provide a means for accurately testing the hearing of infants and small children who are unable to verbalize a response regarding whether or not they heard an acoustically presented stimulus. For this reason, the problem was nominated as a candidate for applications engineering.

PROBLEM SWC-2 *Instrument for Measurement of Evoked Cortical Response by Aural Stimulation*

Many infants and preschool children exhibit characteristic symptoms of retardation and many of these are diagnosed as suffering brain damage while their only problem is that they are deaf or hard of hearing. Since

infants and small children do not respond well to standard hearing tests either because of an inability to speak or accurately orally respond to testing, more accurate methods are required which will enable the doctor to determine if there is indeed brain damage or a hearing defect. Properly diagnosed, treatment can be administered more concisely and deaf children can be brought to the intellectual level of their peers rather than being classified as retarded during the most important formative years, 1 to 6.

The problem originator and his assistants have built up an instrument which illustrates the feasibility of such an approach to check for hearing defects in infants or children, but have encountered problems that involve so much attention that reliable data are difficult to attain.

Electrode and earphone attachment with infants and small children is difficult because of their tendency to knock them off. The proposed solution involves a modified football or baseball helmet which is described in problem SWC-1 and will be incorporated into the final system.

Electrode noise and cabling problems compound the first stage noise level of their biopotential amplifier. This problem has been solved (SWC-9) and is discussed in detail in the Transfer section of this report.

Other problem areas in the design of the instrument in operation include that: (1) The unit is made up of cumbersome subassemblies which require much switching, knob twisting, and cabling, requiring the involvement of at least two people to set up, (2) the problem originator would like to vary the rise time of the tone burst as per the specification sheet which he is now not able to do with his existing circuitry.

To provide an effective screening instrument for the use described above, the team proposed applications engineering to reduce the size, weight, and improve operational characteristics of the investigators' system. It was felt that NASA developments in circuitry could produce a system which was portable, so as to optimize its use as a mass screening device.

PROBLEM LVA-1 *Lightweight EEG Preamplifier for Drug Studies*

The effects of certain drugs on brain activity are being studied at a West Coast hospital by recording potentials via probes implanted in the brains of experimental animals. Signal-to-noise ratio in the present system is not sufficient to permit high fidelity recording of brain-generated voltages.

Since electrical noise in physiological data acquisition systems can sometimes be significantly reduced by locating suitable preamplifiers very near the electrodes or transducers employed to pick up the signals, the team conducted a search of the NASA Data Bank to identify appropriate technology.

It appeared that the small preamplifier developed at NASA-Ames by Thomas B. Fryer and Gordon J. Deboo, Figure 29 (as reported in *Medical Electronics & Biological Engineering,* Vol. 3, p 203, 1965), might solve the investigator's requirements if bandwidth can be reduced; gain reduced; and characteristics with single-ended input determined.

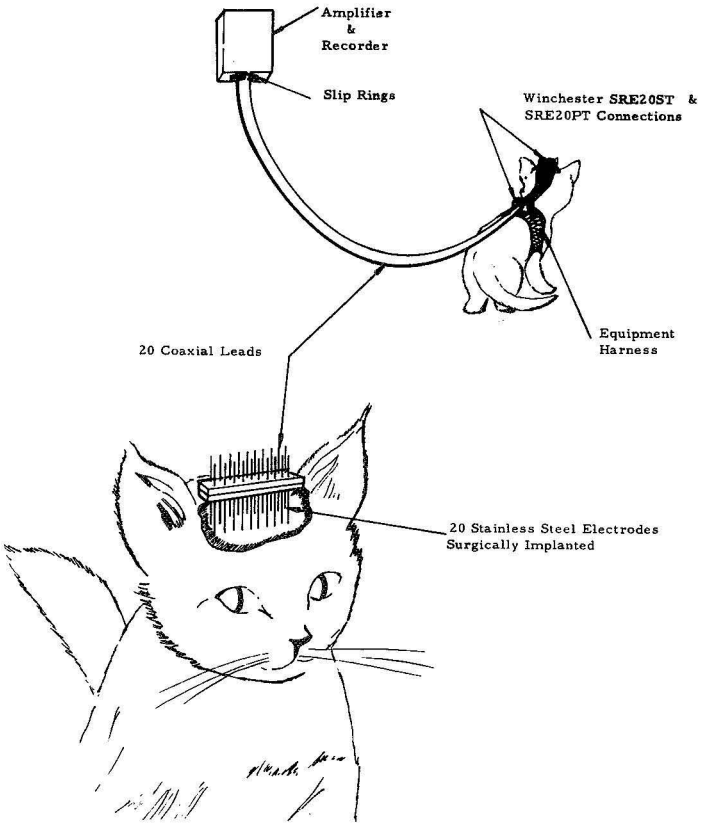


Figure 29. Lightweight EEG Preamplifier for Drug Studies

VI. CONCLUSIONS AND RECOMMENDATIONS

IMPORTANCE OF THE INTERPERSONAL COMMUNICATIVE PROCESS

During the reporting period, the team placed continuing emphasis upon developing techniques for facilitating the transfer of aerospace-related technology to biomedical researchers and practitioners. A considerable portion of this effort was in the direction of motivating these individuals to take advantage of the program. The team evaluated, among others, such techniques as writing personal letters which outlined the program and its goals, following up the letters with personal visits; presenting formal seminars to investigators assembled for this purpose at selected institutions; and scheduling individual conferences with investigators to acquaint them with the general nature of the program. Results obtained with the various approaches were generally comparable, which suggests that the interpersonal communicative process itself—and not the particular technique—constitutes the most important dimension in generating investigator interest in the program. Experience gained to date on the program also suggests that in order to obtain even a modest number of high-impact aerospace technology transfers, it is necessary to identify and process a considerable number of problems. This is necessary for several reasons: (1) Irrespective of how carefully problems are screened and how rigid acceptance criteria are, only a very small percentage of problems eventuate in technology transfer; and (2) participation in the program by biomedical investigators; that is, their willingness to submit problems, evaluate, and utilize solutions offered from aerospace technology is, in a large measure, dependent upon their conviction that the program is in fact designed to help them in their endeavors. If the team imposed an evaluative dimension, which in essence told the investigator that "Yes, you do have an important problem—and we could possibly solve it via aerospace technology—but we cannot accept it because it would not stand out," the flow of problems would be severely curtailed. It appears necessary that, to function effectively and generate and sustain wide support for the program within the biomedical community, the team must accept—and produce solutions for—biomedical problems which might be categorized as suboptimal with regard to the visibility potential of any resulting technology transfer.

MOTIVATIONAL CONSIDERATIONS

The team faces a continuing problem in motivating individuals in the biomedical community to:

(1) Use the program,

(2) Evaluate potential aerospace technology transfer solutions on a timely basis, and

(3) Provide needed minimal feedback regarding utility of offered solutions.

The two latter considerations constitute a considerable source of difficulty. They inject significant time delay in achieving technology transfer. Improved follow-up surveillance of active problems is directed to reduce the delay. This stimulates the investigator to follow through. Meaningfully active consultation is provided for applying the suggested aerospace technology to solve the investigator's problem.

The physician-researcher sometimes may be ill-equipped to fully evaluate complex solutions provided from aerospace technology. The team provides an interactive relationship consultation when required. This can be the means for expediting the technology transfer and it can help to produce positive results which measure the aim and efficiency of the program.

ATTITUDES OF PARTICIPANTS

One of the most important dimensions of the project centers upon the human factor. A variety of attitudes are encountered in the interactions of the team with the biomedical community. They range from

enthusiastic and positive support to extreme negative bias against the program. A significant degree of interpersonal skill is required to generate and sustain long-term interest. That interest is required to make a successful technology transfer program.

Many program participants consider themselves as the experts in their particular fields. They are proud of their own capabilities as experts, and this sometimes generates resistance to using ideas originating elsewhere. Some investigators also resist seeking problem-solving help until it is essentially too late for optimal impact of applicable aerospace technology. Substantial savings of time and funds possibly could be achieved if appropriate aerospace technology is requested at an earlier stage to solve a particular problem.

Reticence in a small number of cases can be attributed to proprietary considerations. Some may fear that their research effort may be compromised or seized upon by outsiders during an innovative research effort. They resist dissemination via formalized program reports. Investigators who conceivably could make significant contributions to the program consider these circumstances sufficient reasons to avoid participating.

Skilled interpersonal exchange between the investigator and the team member effectively modifies many of the negative postures. The interpersonal dimension constitutes the critical link in the chain of events determining whether or not technology may be transferred. Identification of biomedical problems which are suitable for consideration by the program is secondary according to team experience.

NEED FOR IMPROVED INTERACTION WITH NASA RESEARCHERS

A task for the future centers upon development of techniques for more adequately tapping the expertise available within NASA research facilities. Access to concepts and developments is particularly important to help solve significant biomedical problems. Some of them remain in the minds of NASA engineers or scientists without appearing in a technical paper or report. There seems to have been a tendency in the past to view the technology transfer effort as hardware oriented. Although it is important to be able to transfer unique NASA-developed instrumentation, and make it available for biomedical use, sole focus upon hardware transfer severely limits input to the program. In this regard, it is appropriate to take a broader view of the term aerospace technology. While it does in fact consist of hardware end-items resulting from aeropace effort, it also consists of facts, skills, and techniques which were drawn from science and engineering effort undertaken to develop the hardware end-items.

Many types of technology can be transferred. They include processes and procedures on research, engineering, and manufacturing. Technology also consists of designs for end-items, tools, and test equipment; analytical methods and techniques. The capability for problem solving, analyzing, inventing, designing, and testing is a factor of equal importance.

This technology generally is stored in files, models, capital equipment, or computerized data banks. The type which remains within the individual NASA researcher is significantly important for the program. Their potential contributions should be brought to light and directed to appropriate users.

Problem Statements have been circulated by NASA Technical Utilization Officers at various research centers. These are useful and have produced results. An additional mechanism is needed as an optimal means for matching potentially available NASA expertise with biomedical problems submitted by the team. The personnel limitations at the NASA Center Technology Utilization Office level and the large number of active problems being fed into the system indicate the need for expanded contact concepts.

Experimental live-in programs and seminars have recently been conducted and they offer hope for the expanded contacts at the NASA Manned Spacecraft Center. These may develop into an effective means for channeling NASA expertise toward problem solutions needed in biomedical research communities.

APPENDIX A

PROJECT ACTIVITY SUMMARY

TRANSFERS ACCOMPLISHED

BLM-12 *Flexible Electrode for Stimulating the Carotid Sinus Nerve*

SWC-9 *Noise Level Correction for Audiometric Measurements*

CAP-2 *Galvanic Skin Response Electrodes for Long-Term Applications to Human Subjects*

HUV-18 *Microanalysis of Mucus-Secreting Cells*

NWR-6 *The Effects of Electromagnetic and Acoustic Fields on Living Organisms*

SFM-3 *Improved Monitoring of Heart Cell Parameters*

UTM-19 *Electrodes for Measurement of Heart Rate in Active Experimental Animals*

WSM-6 *High-Power Infrasonic Wave Generator*

UTM-11 *Motion Transducer for Studies on Small Animals*

UTM-13 *Small Animal Posture Indicator*

UOF-1 *Tape Head Maintenance for Hospital Computer*

POTENTIAL TRANSFERS IDENTIFIED

UTM-9 *Tidal Volume Measurements in Respiration Studies*

DLM-4 *Doppler Probe Holder and Stand for Use on Chronic Measurements of Fetal Circulation*

DLM-2 *Temperature Measurement of Brain Core in the Laboratory Rat*

BLM-14 *Compound Conduit Umbilical for Chronically Surviving Animals*

DLM-12 *Automated Circulation Control System for a 100,000-Volume Medical Library*

SWC-4 *Information Retrieval System for Clinical Records*

HSR-1 *Impression Material for Making Pattern of the Lower Trunk*

UFM-5 *Skull Cap Transducer Assembly for Neurological Studies in Cats*

BLM-11 *On-Line Analysis of Biochemical Samples Collected Automatically from Patients*

BLM-11a *On-Line Analysis of Biochemical Samples Collected Automatically from Patients*

BLM-13 *Nonthrombogenic Material for Use as a Blood Interface*

SWC-1 *Improved Techniques for Taking EEG in Infants and Small Children*

SNM-5 *Implantable Telemetry System for ECG*

RNV-14 *Materials for Prevention of New Decubitus Ulcers*

DVM-4 *Automatic Atraumatic Blood Pressure Measurements*

CAP-1 *Apparatus for Telemetering GSR in Natural Social Settings*

UTM-7 *Chronic Electrode Implantation Techniques for Artificial Eye Research*

SNM-4 *Improved Techniques for Measurement of Skin Thickness*

RNV-28 *Accelerometer for Human Motion Studies*

RNV-13 *Improved Laryngoscope for Use in Disabled Children*

NWR-5 *Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section*

DLM-6 *Measurement of Respiration Parameters of Cardiovascular Patients*

CURRENTLY ACTIVE PROBLEMS AS OF AUGUST 1970

Problem Number	Status Code*	Problem Title
AVA-1	B	*Chest Wall Movement Transducer for ECG Measurement*
BLM-10	D	*Computer Programs and Systems for Analysis of the ECG*
BLM-12	F	*Flexible Material for Connecting Electrical Stimuli to Nerves Without Damage*
BLM-13	E	*Nonthrombogenic Material for Use as a Blood Interface*
BLM-14	E	*A Compound Conduit for Chronically Surviving Animals*
BLM-16	C	*Measurement of Electrolyte Concentrations in Renal Medulla and Papilla*
BLM-17	B	*Improved Procedure to Measure Regional Blood Flow in Kidney*
BLM-21	C	*Artificial Membrane Interface*
BLM-22	B	*Expired Oxygen Analysis*
BLM-23	C	*Germ Free Hamster Colony*
BLM-24	C	*X-Ray Exposure and Gravitational Effects on Body Functions*
BLM-25	A	*Simple Economical Mass Screening Techniques for Analysis of ECG in Clinical Diagnosis and Multiphasic Health Screening*
BVA-1	B	*X-Ray Transparent Electrodes and Leads*
BVA-2	B	*Punch Card Group Selector*

*See explanation of status codes at end of listing.

Problem Number	Status Code	Problem Title
BVA-3	B	*Attachment Techniques for ECG Electrodes*
BVA-4	B	*Portable ECG Telemetry Receiver and Chart*
CAP-3	F	*Noncomputerized Reduction of Data Recorded Via Conventional Polygraph Techniques*
DLM-1	D	*Pressure Measurement of Brain Ventricle and Renal Arteries of a Rat*
DLM-2	E	*Temperature Measurement of Brain Core in the Laboratory Rat*
DLM-4	E	*Doppler Probe Holder and Stand for Measurement of Fetal Circulations*
DLM-5	D	*Measurement of Fetal Circulation from Transcutaneous Transducers*
DLM-9	C	*Aerial-Image–Fiber-Optics Interface*
DLM-10	C	*Precision Optical Plastics Fabrication*
DLM-11	D	*Improved Teaching Techniques on Medical Subjects*
DLM-14	C	*Detection of Kidney Stones During Surgery*
DVA-1/2	D	*Automated Techniques for Administration and Analysis of Diagnostic and Therapeutic Psychological Tests*
DVM-1	F	*Improved Measurement of Mechanical Properties of Tissue*
DVM-2	F	*Collimation of X-Particle Beam*
DVM-5	B	*Monitoring Blood Gases*
DVM-6	F	*Measurement of Acceleration of the Human Head*
DVM-7	B	*Requirement for Special Photographic Equipment*
DVM-8	B	*Wireless Telemetry for Accelerometer Information*
GIT-1	B	*Pulsatile Flow in Elastic Tubes for Analysis of Biocompatible Materials*
GIT-2	B	*Charged Test Objects in Blood Substitute for Clot Formation in Cardiovascular Research*
GIT-3	B	*Flow Fields Around Sphere for Clot Formation Studies in Cardiovascular Research*
GIT-4	B	*Determination of Blood Clot Thickness in Cardiovascular Research*

Problem Number	Status Code	Problem Title
GIT-6	A	*Friction and Wear Characteristics of Compatible and Noncompatible Materials in Artificial Organ Research*
GIT-7	B	*Blood Coagulation Effects Induced by Nonionizing Radiation in Artificial Organs Research*
GIT-8	B	*Biocompatibility of Materials by the Application of Electric Charge*
GLM-19	D	*Measurement of the Velocity of Myocardial Contraction by Noninvasive Means in Heart Research Impact Area: VII–Heart Disease Detection and Treatment*
GLM-20	D	*Continuous Destruction of Lymphocytes Under Sterile Conditions in Organ Transplant Patients Impact Area: IV–Artificial Organs*
GLM-21	D	*Steady Convective Dispersal in Parallel with Developing Diffusive Dispersal as in Blood Capillaries*
GLM-22	C	*Ear Defenders for Industrial Workers*
GLM-23	D	*Determination of Attractive Forces Between Red Blood Cells*
GLM-29	C	*Determination of Cerebral Dominance in Man*
GLM-30	C	*Electrical Model for Transmission of Information Within a Single Cell*
GLM-31	D	*Electrodes for Esophageal Speech Improvement*
GLM-32	B	*Electrocardiogram Preamplifier for Home-Type Tape Recorder in Heart Disease Detection and Treatment*
GLM-33	B	*D.C. Operated Proportional Temperature Controller for Use in Pollutant Studies*
GVA-1	B	*Food and Water Control for Small Animals in Obesity Studies*
GVA-2	B	*Urinalysis Techniques for Highly Volatile Compounds*
GVA-3	B	*Automatic R-Wave Detector for Heart Rate Measurements*
GVA-4	B	*Electro-Stimulation Devices and Electrodes for Psychiatry Research*
GVA-5	B	*Computer Analysis of ECG Waveshapes*
GVA-6	B	*Respiration Monitor*
HSR-1	D	*Impression Material for Making Pattern of Lower Trunk*

Problem Number	Status Code	Problem Title
HSR-2	D	*Resilient, Breathing Contour Seat Material*
HSR-3	D	*Padding Material for Orthotic Devices*
HSR-4	B	*Wheelchair Starting Control*
HSR-5	B	*Wheelchair Power Source*
JVA-1	B	*Fluorometry Test Sample Temperature Regulation*
LAC-1	B	*Method for Analyzing Blood Flow Velocity Information*
LLU-1	B	*Fermentation Process Applied to the Handling of Waste Products in Ecology Studies*
LLU-2	B	*Protein Synthesis Approach to the Handling of Waste Products in Ecology Studies*
LLU-3	D	*Methods for Data Acquisition and Computer Program to Analyze EEG and Evoked Responses for Multiphasic Health Screening and Clinical Diagnosis*
LLU-4	A	*Compatible Low Flow Resistance, Small Bore Tubing for Biochemical Analyzer*
LLU-5	B	*Method for Taking Repeated Biopsies of Soft Tissue Through a Single Portal in Cancer Detection and Treatment*
LLU-6	D	*Noninvasive Minimal Encumbrance Methods for Acquisition of Physiological Data for Improved Surgical Procedures*
LLU-7	C	*An Adjustable Histamine Aerosol Generator for Air Pollution Studies*
LLU-8	B	*Methods for In-Flight Tracking of Medically Significant Insects*
LLU-9	B	*A Simple and Economical Method for Oxygen Isotope Tracing in Lipid Periosidase In Vitro and In Vivo*
LVA-1	D	*Lightweight EEG Preamplifier*
LVA-2	D	*Methods for Neurological Data Handling*
LVA-3	A	*Radioactive Cell Counting Method*
LVA-4	B	*Research Facility Design and Planning*
LVA-5	B	*Device for Weighing Laboratory Rats*
LVA-6	B	*Method for Measuring Temperature of Laboratory Rats in Isolation Chambers*

Problem Number	Status Code	Problem Title
LVA-7	B	*Method for Acquiring ECG Information from Laboratory Rats in Isolation Chambers*
NIH-1	B	*Hydraulic System for Hospital Cart for Improved Patient Transportation*
NIH-2	B	*Management Techniques to Coordinate Remote Health Services with Hospitals*
NMA-1	B	*Program to Establish Electrical Safety Standards for Equipment and Instruments Used Around Patients*
NMA-2	B	*Coiled Transducer Cables for Rough Environmental Use*
NMA-3	B	*ECG Cable Take-Ups for a Portable ECG Monitor in an Intensive Care Unit*
NMA-4	B	*Spray-On Electrodes for Intensive Care Patients*
NMA-5	B	*Cable Crimping on Simmons Bed*
NMA-6	B	*A Demand Water Level Float for Nebulizer in Inhalation Therapy*
NMA-7	B	*Ultrasonic Catheter Transducer for Pulse-Echo Measurements in Cancer Research*
NMA-8	B	*Ultrasonic Techniques to Support Radiological Therapy in Cancer Research*
NMA-9	B	*Low Cost Dialysis Scrubbing Pads*
NMA-10	B	*Video Tape Programming for Speech Therapy*
NMA-11	B	*Computer Programmed Testing and Teaching in Speech Therapy*
NWR-5	D	*Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section*
OVA-1	B	*Indirect Blood Pressure Measurement–Without Occlusive Cuff*
OVA-2	B	*Measurement of Lung Compliance*
OVA-3	B	*In Situ Measurement of Surface Tension of Lungs*
RNV-14	D	*Cushions for Spinal Cord Injury Patients*
RNV-21	C	*A Wireless Synchronization Link*
RNV-22	D	*Overload Protection for Permanent Magnet, Direct Current Motors Used in Orthotic Devices*
RNV-23	D	*Analysis of Body Motions*

Problem Number	Status Code	Problem Title
RNV-24	C	*Anticipatory References*
RNV-25	C	*Determination of Precise Orientation of the Spine*
RNV-26	D	*Angle Measurement in Knee Prosthetics*
RNV-27	C	*Intramyocardial Electrode*
RNV-28	F	*Accelerometer for Human Motion Studies*
RNV-29	C	*Manual Controls for Self-Propelled Vehicle (Wheelchair; Automobile)*
RNV-30	C	*Power System for Wheelchair*
RNV-31	C	*Patient-Supporting Couches*
RNV-32	D	*Measurement of Energy Expended in Walking*
RNV-33	A	*A Nerve Stimulator Electrode for Stroke Patients*
SJH-1	D	*Interfacing Biochemical Autoanalyzers with a Computer*
SNM-4	C	*Device for Obtaining Precision Measurements of Skin Thickness*
SNM-6	C	*Computerization of Diagnostic X-Rays*
SNM-7	C	*Information Theory (Shannon's) as Applied to X-Rays*
SNM-8	B	*Bone Mineral Measurement Utilizing X-Ray Techniques*
SNM-9	B	*Chemical Analysis of Biological Molecules Utilizing X-Ray Fluorescent Techniques*
SNM-10	B	*Portable Recording Stethoscope*
SNM-11	D	*Quantitative Analysis of Polyethylene Oxide*
SNM-12	D	*Measurement of Uterine Artery Dimensions*
SNM-13	D	*Miniature pH Electrode for Fetus*
SNM-14	D	*Fetal ECG Telemetry*
SNM-15	D	*Uterine Pressure Telemetry*
SNM-16	D	*Techniques for the Prevention and Control of Contamination of Food Fish Mollusks and Crustaceans*
SNM-17	D	*Measurement of Fallopian Tube Muscle Activity and Muscle Electropotential of Experimental Animals*

Problem Number	Status Code	Problem Title
SNM-18	B	*Detection of Poliwater and Its Variations in Cells by Resonance Microwaves in Basic Research*
SNM-19	A	*Computer Based Health Records Systems Development*
SRS-8A	F	*Acquisition and Telemetry of Heart Rate, Blood Pressure, and Blood Flow in Free-Ranging Dogs*
SRS-8B	F	*Methods of Signal Categorization*
SWC-1	E	*Improved Techniques for Taking EEG in Infants and Small Children*
SWC-2	B	*Cortical Audiometry Measurements*
SWC-3	B	*Differentiation Between Normal and Abnormal (Tumor) Tissues by Ophthalometric Techniques*
SWC-4	D	*Information Retrieval System for Clinical Records*
SWC-5	B	*Technique for Recovery and Separation of Amylase from Polyacrylamide Gels*
SWC-6	B	*Apparatus for Micropuncture of Pancreatic Gland*
SWC-7	B	*Improved Scan Resolution of Radioisotope-Filled Organs*
SWC-8	B	*Improved Method for Computing X-Ray Dosage*
SCW-10	D	*Microcirculation of the Islets of Langerhans*
TCM-3	B	*Peak Detector for Signal Conditioning of Blood in Basic Medical Research*
UAM-1	B	*Capacitative ECG Electrodes*
UAM-2	B	*Heart Sounds Telemetry*
UFM-1	B	*Method for Determination of Maximum Stress in Long Bones*
UFM-2	B	*Determination of Interfacing Properties of Specific Ceramic Material to Bone*
UFM-3	B	*Mathematical Model for Urinary Stone Formation in Basic Medical Research*
UFM-4	B	*Rapid Quantitative Analysis of Urine Constituents in Health Care Cost Reduction*
UFM-5	E	*Skull Cap Transducer Assembly for Neurological Studies in Animal Experimentation*

Problem Number	Status Code	Problem Title
UFM-6	D	*Xeroradiography of Mammary Glands for Cancer Detection and Multiphasic Health Screening*
UFM-7	D	*Methods for Computer Analysis of EEG for Health Care Cost Reduction*
UOF-1	D	*Tape Head Maintenance for Hospital Computers*
USC-1	D	*Method for Attaching a Tension Connection to the Skin to Measure Skin Elasticity for Clinical Diagnosis*
USC-2	D	*Skin Elasticity Measurement*
USC-3	C	*Patient/Specimen Identification Method*
USC-4	D	*Method for Measuring Rate of Change in Physiologic Data*
UTM-1	B	*Physiologic Data Handling-Systems Approach*
UTM-2	F	*Microminiature Pressure Transducer*
UTM-3	D	*Proton Magnetometer for Use as a Flowmeter*
UTM-4	D	*Detection of Blood Clot Formation in Artificial Arteries By Pulse-Echo Techniques*
UTM-6	D	*Stress Analysis of Artificial Heart Valve*
UTM-7	D	*Chronic Electrode Implantation Technique for Artificial Eye Research*
WVA-1	B	*Suitable Fluid for Foot Pressure Indicating Device*
WVA-2	B	*Electrodes for Measuring Tooth Potentials*
UTM-18	D	*Peripheral Stimulation Devices*
UTM-17	D	*Biotelemetry and Stimulation for Free-Ranging Animals*
UTM-15	D	*Dust Mills for Aerosol Generators*
UTM-14	D	*Animal Position Monitor*
UTM-12	D	*Biotelemetry for Animal Tagging in Ecological Studies*
UTM-20	B	*Use of Critical Management Techniques for Artificial Organ Development*
GLM-27	C	*Repetitive Photography of Animal Behavior in Dim Light*
GLM-34	B	*Protective Coating of Precision Optical Instruments to Prevent Corrosion*

Problem Number	Status Code	Problem Title
PVA-1	B	*Cellular Aging Caused by Ionizing Radiation, Weightlessness, and Exotic Gases*
PVA-2	B	*Capabilities for Characterizing New Compounds Derived from Tumors*
PVA-3	B	*EEG Analysis Computer Programs*
PVA-4	B	*EEG Electrode Holders*
PVA-5	B	*Low-Noise EEG Preamplifiers for Clinical Research*
SRS-9	B	*Electromagnetic and Ultrasonic Doppler Blood Flow Velocity Measurement Methods*
USC-6	B	*Nonocular Methods for Monitoring Vestibular Function*
USC-7	B	*A Method for Measuring Angular Rotation of the Eye*
USC-8	B	*Methods for Organizing and Analyzing Nystagmographic Data*
USC-9	B	*Methods for Obtaining Otological Response in Experimental Animals*
USC-10	B	*Nonsurgical Methods for Treating the Inner Ear*
USC-11	B	*An Implantable Bone Pressure Transducer Effects*
USC-12	B	*Effects of Procaine Hydrochloride on Experimental Animals*

STATUS CODE DEFINITIONS

A. Problem Definition

Problem definition includes the identification of specific technology-related problems through discussions with biomedical investigators and the preparation of functional descriptions of problems using nondisciplinary terminology.

B. Information Searching

Information relevant to a solution is being sought by computer and/or manual information searching.

C. Problem Abstract Dissemination

An information search has revealed no potential solutions and a problem abstract is being circulated to individual scientists and engineers at NASA centers and contractor facilities to solicit suggestions.

D. Evaluation

Potentially useful information or technology has been identified and is being evaluated by the team and/or the problem originator.

E. Potential Transfer

Information or technology has been evaluated and found to be of potential value but has not been applied.

F. Follow-Up Activity

Useful information has been identified, but further activity (i.e., documentation, obtaining experimental validation of utility, continuing modification, etc.) is required.

APPENDIX B

DESCRIPTION OF CURRENTLY ACTIVE PROBLEMS (CATEGORIZED BY HEALTH AREAS)

COMMUNICABLE DISEASE DETECTION AND TREATMENT

PROBLEM SNM-3 *Modification of the Surface of Controlled Pore-Size Glass to Eliminate Adsorption*

An investigator uses exclusion chromatography with controlled pore-size glass to purify viruses for vaccine production. The glass pore-sizes range from 50 to 200μ. The glass is crushed, screened, and packed into columns to become an ideal matrix for exclusion chromatography with the polio virus and other select kinds of viruses. The system cannot be used with the rabies virus and some of the other kinds of viruses because they excessively adsorb to the glass surface. Adsorption occurs at pH's where net charge of the virus is negative. The investigator needs a glass surface modification technique which eliminates adsorption without rendering the glass surface hydrophobic, and avoids plugging the glass pores.

A WESRAC computer search was made, and though no pertinent literature was obtained from this search, the results were forwarded to the problem originator and a Problem Statement was submitted to NASA for approval to disseminate to their research centers.

MULTIPHASIC HEALTH SCREENING AND CLINICAL DIAGNOSIS

PROBLEM BLM-25 *Simple Economical Mass Screening Techniques for Analysis of ECG in Clinical Diagnosis and Multiphasic Health Screening*

The researcher at a Southwest medical institution requires an inexpensive technique for detecting latent heart disease by automatic analysis directly from the patient's heart electric signal (ECG). This will permit implementation of a large-scale, multiphasic health screening program. The method and device must be economical, reasonably portable, adaptable to a minimum number of trained staff personnel, and reliable for mass screening procedures. The NASA real-time analysis of astronaut and spacecraft functions technology may perform ideally in this transfer application.

Available NASA technology is currently being evaluated and transfer of an aerospace application is likely.

PROBLEM UFM-7 *Computer Analysis of the EEG*

Researchers at a hospital are attempting to mass screen patients as a community service to determine which patients require further medical attention and identify needed medical help areas for each patient. Computer analysis of EEG recordings is desired to reduce costs and increase speed.

NASA-developed technology for processing medical information was provided to the problem originator. A medical information systems seminar to introduce and demonstrate NASA systems was held at the Manned Spacecraft Center in July of 1970. Technology developments were included in the presentation pertinent to the researcher's problem.

PROBLEM SNM-6 *Computerization of Diagnostic X-Rays for Multiphasic Health Screening*

Computer science has been applied as an experimental tool in practically every area of endeavor and has not been limited to just data processing. There does appear to be a shortage of computer technology in the x-ray diagnostic techniques. This may be due to the reasonably constant dose rate over long periods of time in conventional x-ray therapy units. The operators of these units are provided charts and tables which show the times for different tumor doses. Most computer techniques involve x-ray therapeutic application, however, and are not used for diagnosis. Selected computer technology is needed to integrate into a devised arrangement for simplifying, standardizing, and maximizing radiology clinic use of all diagnostic radiographic information and x-ray techniques.

NASA literature was manually searched. NASA Tech Brief 69-10139 was retrieved with its technical support package and was forwarded to the problem originator, together with other pertinent reference

materials. According to the evaluation received from the problem originator, NASA technology was very helpful and may be a key to the problem solution.

PROBLEM SWC-1 *Improved Techniques for Taking EEG in Infants and Small Children*

Investigators at a Southwest hospital are perfecting a technique for using EEG to test hearing of infants and small children. Thousands of children have been classified as mentally retarded when their problem has been a hearing difficulty. The hearing abnormality cut them off from the auditory interchanges required to develop the intellect. The investigators believe they can identify hearing defects early in infancy and apply appropriate remedial measures (hearing aids) to prevent many youngsters from becoming functional mental retardates. An EEG-electrode instrumented helmet is to be equipped with earphones to administer the auditory signal, and substantially will assist in identifying hearing defects in individuals who cannot verbally communicate whether they can hear an auditory stimulus and to what degree they hear it.

A NASA-developed device may be modified to answer requirements of this problem. A potential transfer report was written and the problem was submitted to NASA as a candidate for applications engineering. The problem originator was furnished copies of NASA Tech Brief 66-10536 and USAF Publication ARL-TR-69-17-6571, which provided the basis for the reengineering effort.

PROBLEM SWC-2 *Cortical Audiometry Measurements*

Infants and preschool children may exhibit characteristic retardation symptoms. Many of them have been diagnosed as suffering from brain damage when their problem is deafness or a hearing defect. Infants and small children are unable to accurately speak or respond to ordinary hearing tests. Accurate methods are needed for the doctor to determine if there is a hearing defect or if indeed there is brain damage. Concise, properly diagnosed treatment can be administered to bring deaf children to the intellectual level of their peers during years 1 to 6, the most formative years.

The researchers have constructed a device illustrating the feasibility of discovering hearing defects in infants and young children. Problems encountered with the current system require so much attention that reliable data are difficult to obtain. Electrode and earphone attachments are difficult to maintain because the youngsters tend to knock them off. The proposed solution is described in Problem SWC-1 and involves incorporating a modified football or baseball type helmet into the final system. Electrode noise and cabling problems compound the first stage noise level of their biopotential amplifier. Problem SWC-9 provided a solution to this problem and it is discussed in detail in the Transfer section of this report.

There are other problem areas in the design for the instrument in operation. The unit is composed of cumbersome subassemblies. They require much switching, knob twisting, and cabling. At least 2 people are involved in setting up the unit. The problem originator prefers to vary the rise time of the tone burst as indicated in a specification sheet. The existing circuitry does not permit this.

This problem has been accepted as an applications-engineering candidate.

PROBLEM SWC-9 *Noise Level Correction for Audiometric Measurements*

Characteristic, total, or partial deafness symptoms of infants and small children often lead to clinical diagnosis of mental retardation. Infants and small children are unable to accurately respond to standard methods of auditory tests. Alternate methods must be used to accurately determine related audio responses and ear conditions. Measurement of evoked cortical responses to audio stimuli uses a method and instrument to produce such results. The measurement technique applies audio signals by earphones and monitors the evoked response (EEG).

The problem originator designed an EEG preamplifier monitor to measure minute skull signals. Electrode-interface and lead noise was encountered and the investigator was unable to reduce preamplifier noise level below 3.0μ volts, peak-to-peak.

NASA Data Bank search retrieved A66-12989 *A High-Performance Miniaturized Preamplifier for Biological Applications* by Thomas B. Fryer and Gordon J. Deboo of the NASA Ames Research Center. It was considered to be a potential solution for the problem.

A prototype was built, checked, and sent for evaluation to the problem originator. He was pleased with his findings and currently is using the device for his measurements. A 2-to-1-noise improvement has been achieved. A comparison table for the original prototype and NASA prototype is shown:

	Original Prototype	NASA Prototype
Voltage Gain	1000	1000
Input Z	22 M	24 M diff
Output Z	50	50
Noise Referred to Input	3μ volts p-p	1.4μ volts p-p
Band Width	3 to 100 Hz	15 to 100 Hz
Common-Mode Rejection	20,000 to 1	25,000 to 1

PROBLEM USC-1 *Method for Attaching a Tension Connection to the Skin*

Glue, suction, or other methods are needed for making a temporary, mechanical connection to the skin to measure skin elasticity. The researcher needs a satisfactory means to quantitatively measure skin elasticity. The clinician pinches and pulls the skin as a qualitative test for elasticity in conjunction with other clinical diagnostic information to detect and evaluate the severity of forms of Hansen's disease and other congenital conditions or diseases. A more quantitative test procedure would be expected to provide more valid information and could be performed by paramedical personnel.

The diameter of skin contact point should not exceed 1 cm. Tension should be about 2 psi maximum. Connection for 2 min or less will be required. The skin should not be damaged and the method should be reasonably atraumatic.

Information for a torque method of measuring skin tension was obtained and is being followed up. A skin glue, under development at a military hospital, additionally offers a possible alternate solution to the problem. The team is presently seeking a source of the glue to acquire samples of it.

PROBLEM DLM-9 *Aerial Image Fiber Optics*

The problem is part of a program to develop a more accurate, rapid, and comfortable method of examining the posterior, inner part of the eye (fundus oculi). This is the portion of the eye as seen through the dilated pupil. The program intends to serve 3 functions: patient examination, improved patient records, and medical teaching. Research and development is directed toward projecting the desired image upon a screen. This provides simultaneous viewing by consultant specialists as well as medical students. A conventional motion picture screen or TV monitor could be used for the projection. An "interface" unit from the aerial image to fiber optic cable also is needed. The interfacing unit must be relatively small in size to carry an image as seen through the pupil of the eye.

A NASA Data Bank search retrieved relevant literature. This literature and additional articles on optical systems were sent to the problem originator. Response is needed from the problem originator before the team can direct further technology applications efforts.

PROBLEM DLM-10 *Precision Optical Plastics Fabrication*

A medical school ophthalmologist is investigating improved methods for observing the interior of the eye. He is designing optical mirror systems which will permit the physician to examine the interior eye surface near the pupil. This will permit observation of the posterior surface of the muscles supporting the biologic lens and observation of the retina in the region immediately adjacent to the muscles which support the eye

lens. A system of mirrors to provide the desired optical path has been designed. More fabrication technology is needed to construct a mirrors-in-plastic system.

Results from a NASA Data Bank search were provided to the problem originator. A list of fabricators for such devices was provided from the contacts made with the NASA Marshall Spaceflight Center and Ames Research Center. It also was furnished for evaluation and use by the problem originator.

PROBLEM SNM-10 *Portable Recording Stethoscope*

The investigator needs a small, portable stethoscope to record cardiac and respiratory sounds on a permanent record (e.g., magnetic tape). The records could be used to provide playback of such phenomena for comparative longitudinal studies. It also could be used to improve diagnostic techniques in areas where heavy equipment is not readily transportable. There is a potential here for making important contributions to teaching, research, and diagnosis.

A NASA-developed phonocardiograph system was identified and obtained for evaluation by the problem originator. A team member learned from a recent Manned Spacecraft Center visit that the School of Aerospace Medicine has a portable recording stethoscope. The problem originator was furnished this information and will contact the school to determine if their equipment meets his needs.

PROBLEM BLM-10 *Computer Programs and Systems for Analysis of the Electrocardiogram*

Identification of existing computer programs which provide automatic diagnostic interpretation of the electrocardiogram is needed. Portions of these programs are intended for adaptation to a small computer system, to provide multiphasic health screening in multiple testing of large numbers of subjects. It should be economically feasible for clinical use.

Results of a NASA Data Bank search were forwarded to the problem originator. Information obtained about a device developed at Mount Siani Hospital in Cleveland, Ohio, was forwarded for evaluation by the problem originator. A Medical Problem Statement was approved by NASA for dissemination to the NASA research centers. Several responses were received. NASA Tech Brief B69-10720 on *Biomedical Bulk Data* was forwarded to the team by Mr. Clint Johnson, Flight Research Center, Edwards Air Force Base, California. Mr. Lee DeGoff, TUO Kennedy Space Center, also sent information about work being done at Manned Spacecraft Center on the vectorcardiogram-analysis project phase of the Apollo Applications Program which might be closely related to the problem. Mr. Juan Pizarro II, NASA Marshall Space Flight Center, provided useful information. All of this material was furnished for evaluation to the problem originator.

PROBLEM GLM-32 *ECG Preamplifier for Home Tape Recorder in Clinical Diagnosis*

A Southwest researcher needs a preamplifier to interface an ECG from patients to a home or office type of tape recorder. The instrumentation would be used to monitor the electrocardiogram of a patient functioning in a home or office environment. The preamplifier should have a frequency response from 0 to 100 Hz, a low noise figure and capabilities for ac or battery power. It also should be adaptable for use with a strain gauge transducer. This system should immensely facilitate acquisition, storage, and editing of biological data, and also it will increase outpatient clinical follow-up capabilities.

REHABILITATION MEDICINE

PROBLEM BVA-2 *Punch Card Group Selector*

The problem originator presently has a machine which tests aged patient learning processes. The problem originator prefers to skip certain punch card groups and proceed to more difficult tasks if the patient advances more rapidly than expected during the testing. The entire stack must be selected sequentially with present methodology. A device allowing for random selection of groups of cards in a card stack is needed.

The NASA Data Bank search retrieved many references relating to card sorting and identification as applicable to the problem. These were furnished for evaluation and suggestions for further search strategy to the team.

PROBLEM DVM-6 *Measurement of the Acceleration of the Human Head*

A substantial number of youths are killed or injured annually in football and other athletic events. Many more have received permanent damage due to head, neck, and spine injuries. Study of the accelerations experienced by certain anatomical structures is expected to lead to better understanding of causes of injuries to the players. It also could produce better helmet designs and facilitate the development of tolerance specifications. A small, light and rugged accelerometer which will measure linear and rotational "G" forces is needed for mounting on a headband when the subject is wearing a football helmet.

A copy of NASA Tech Brief 66-10534 on triaxial accelerometers and data on a BM-1 activity monitor for head blows were sent to the problem originator for evaluation. A Problem Statement was prepared and submitted to NASA for approval to disseminate to research centers.

PROBLEM DVM-8 *Wireless Telemetry for Accelerometer Information*

A substantial number of youths are killed or injured annually in football and other athletic events. Many more have received permanent damage due to head, neck, and spine injuries. Study of the accelerations experienced by certain anatomical structures is expected to lead to better understanding of causes of injuries to the players. It also could produce better helmet designs and facilitate the development of tolerance specifications. The knowledge would also be useful in developing safer aircraft and automobiles. A telemetry transmitter design is needed. It should be capable of sending 3 channels of accelerometer output information from any site on a football field to a receiver located in a press box.

The results of a NASA Data Bank search were forwarded to the problem originator. A Problem Statement was prepared and sent for NASA approval to disseminate to research centers. A team visit to the Manned Spacecraft Center yielded information concerning a system which could solve the problem. Contact has been made with the fabricator of the system, Spacecraft Inc.

PROBLEM DVM-7 *Requirement for Special Photographic Equipment*

Investigators at a West Coast medical school are engaged in a broad research program concerning injuries sustained in the body contact sports (football, etc.). Information is needed to include recommended game rules changes if indicated. The occurrence of head injuries is of particular interest to the researchers. They need photographic apparatus (motion picture or TV) to study this aspect. The apparatus should provide 100% surveillance of a football field. The resultant, recorded image should provide exceptionally high levels of clarity and fidelity. The investigators should be able to observe the details of the actual traumatic event. The image should clearly show the occurrence of immediate posttrauma reactions, facial expressions, facial color, and reflex actions which occur as the player is removed from the field. Exposure control of the photographic apparatus should be automatic. It should function well under extremes of lighting conditions ranging from full sunlight glare to reduced illuminations of night-lighted games with artificial lights.

The results of a NASA Data Bank search were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The team has become aware of additional research accomplished in this area. A request has been made for information on this research.

PROBLEM PVA-3 *EEG Analysis Computer Programs*

The problem originator is studying analysis of electroencephalograms by computer. Research is at the stage of evaluation and revision of design plans and a request has been received for comparative NASA technology.

The team currently is processing preliminary search strategy.

PROBLEM GLM-24 *Portable Stimulator for Esophageal Speech Improvement*

Patients who have surgical removal of their vocal cords experience difficulty in learning esophageal speech. The thoracic contractions required to produce esophageal speech simultaneously blow air out of the tracheal opening and overwhelmingly masks the speech sounds. Normal, partial contraction of the cricopharyngeal muscle partially constricts the trachea during attempted speech and this worsens the blowing sound. The patients can learn to contract the cricopharyngeal muscle completely with much training. If this is accomplished before speech and the trachea is closed off, the undesired sound thereby is avoided. A portable stimulator is needed to train patients for esophageal speech by causing the muscle to contract as required.

The results of a NASA literature search were forwarded for evaluation to the problem originator. A Problem Statement was prepared and sent for NASA approval to disseminate it to research centers.

PROBLEM GLM-29 *Determination of Cerebral Dominance*

Aphasic patients suffer a loss in the power to speak. They can be retrained under some conditions. Improvement in their speech may occasionally be accompanied by the loss of ability to write, etc. This appears to be related to cerebral dominance since the areas for speech appear to be present only on the dominant side. A valid means to determine cerebral dominance is needed. NASA assistance and technology was requested for this determination since it appeared to the investigator that this influences the location of spacecraft controls and/or crew selections.

The results of multiple searches of the NASA Data Bank were furnished for evaluation to the problem investigator. They currently are being applied to this problem.

PROBLEM HSR-1 *Impression Material for Making Pattern of the Lower Trunk*

An interdisciplinary team at a Southwest rehabilitation center is constructing bucket-style, contour chairs. They are used in the care and treatment of spinal cord injury patients, particularly quadriplegic patients. These patients traditionally have been confined to bed during most of their waking hours. When a specially fabricated contour chair is used, however, the patients can be permitted to sit up for extended periods. The researchers need material to more accurately, rapidly, and efficiently prepare impressions of the paralyzed patient's body.

Results were obtained from a search of the NASA Data Bank. A response was received from a NASA research center to the Problem Statement. Relevant technology has been retrieved to solve the problem. Methodology for fabricating a foam-in-place, form-fitting pilot's helmet liner directly on the pilot's head, shows good potential as impression material to make the exact patterns for the lower trunk. Another interesting application of this foam system is consideration as a replacement for plaster of paris cast material for broken bones.

PROBLEM HSR-2 *Resilient, Breathing Contour Seat Material*

A research team at a Southwest rehabilitation center is fabricating and using contour chairs for spinal cord injury patients. The investigators need materials for the contour seat of wheelchair patients. A rigid base material and a resilient, limited degree of cushioning material is needed. Samples of the materials were requested since applicability must be determined empirically.

Appropriate NASA documents were retrieved from a search of literature. NASA-developed polymethane foam material samples were obtained. They were furnished for evaluation to the problem originator. A slit-tube, fiberglass filler material which was developed by NASA is presently being evaluated for prevention of decubitus ulcers (bed sores). This also will be made available for evaluation and use by the problem originator.

PROBLEM HSR-3 *Padding Material for Orthotic Devices*

Orthotic devices are worn by certain patients as mechanical aids to assist functions of weak, paralyzed limbs. Padding is provided at points where the devices contact the skin. The pads must be replaced periodically because the wear and shrinkage cause skin maceration and they become odiferous with use. The patient loses the prosthetic help during times of repair. This is a direct expense and consumes a valuable part of the prosthetist's time. A suitable padding material is needed that should be durable, shrink resistant, porous, and easy to form or shape with cutting instruments.

Team members scheduled a visit to the Manned Spacecraft Center and received referrals to several commercial sources which had developed materials with the needed characteristics in association with NASA. The Medi-Gard Medical Plastics Corporation can supply samples for evaluation by the problem originator of their antibacterial, polypropylene fiber material.

PROBLEM HSR-4 *Wheelchair Starting Control*

A method for achieving a smooth start by speed control in electric powered wheelchairs is needed by researchers who are developing improved patient transportation. A control mechanism must provide good, low-speed regulation and must not add appreciably to the cost of the wheelchair.

NASA technology has been significantly applied to patient transportation areas. An eye-switch was developed for patients who are unable to use either hand or foot. A walking wheel chair was developed which can climb stairs. This technology was made available to the problem originator.

PROBLEM HSR-5 *Wheelchair Power Source*

A small, inexpensive, lightweight power source for powered wheelchairs is needed. Heavy, corrosive, lead-acid batteries which require periodic charging currently are used. The problem originator needs NASA technology to use with the view of reducing the weight, size, and charging frequency of batteries as a more efficient power source.

Fuel cell technology, silver-zinc batteries, nickel-cadmium batteries and modified lead-acid which have been NASA-developed for use in spacecraft are being evaluated by the team for possible application to this problem.

PROBLEM NMA-10 *Video Tape Programming*

Speech therapy at a V.A. Hospital is an expanding program because of the large number of brain-injured Vietnam veterans. The problem originator is attempting to computerize some aspects of therapy to assist in reteaching speech. Insufficient therapists and assistants are available to handle this load. The problem originator strengthens oral signals with visual stimuli and needs programming techniques for video tapes including both video and audio signals.

Multiple searches of related aerospace technology have been made to identify relevant NASA-developed data. Results were furnished to the problem originator and he selected four documents of special interest to him. His evaluation of the document contents will direct future research.

PROBLEM NMA-11 *Computer Programmed Testing and Teaching*

Basically, repetitive programs are used to teach speech handicapped patients. It is frequently desirable to skip one or more sequential batteries in the program after certain patients have mastered a battery. The problem originator needs technology which will permit random selection of the available batteries as needed for effective speech therapy.

Data were retrieved from a NASA-developed technology search and these are being evaluated by the problem originator for follow-up action.

PROBLEM RNV-14 *Materials for Prevention of New Decubitus Ulcers*

Pressure sores (decubitus ulcers or bed sores) develop over the bony areas of the sitting surface of spinal cord injury patients while they are sitting in wheelchairs. Some of the sores require surgical closure. Most of the sores take from 2 weeks to 4 months to heal. The estimated, average cost for treating a decubitus ulcer is about $15,000. Some type of cushioning material which possibly could distribute pressures to eliminate high pressure points on the patient's body would be useful. This material should be somewhat compressible, lightweight, have properties generally described as viscoelastic, and perhaps a gel.

The results of a search of the NASA Data Bank were furnished to the problem originator, who advised the team they were pertinent, direct, and useful. Materials were purchased and cushion research was initiated. Investigations also have been made concerning a special resin from which pads could be similarly constructed. This problem has been classified as an applications engineering candidate.

PROBLEM RNV-21 *A Wireless Synchronization Link*

The investigator stimulates muscles to correct for dropfoot in the care and treatment of stroke patients. Patients tend to drag the affected foot because the muscles do not function which raise the foot at "stepoff." Researchers electrically stimulate the appropriate nerve in the affected leg. They do this through implanted electrodes and inductively coupled radio frequency energy. The stimulator has several basic parts. These are a waist-belt-mounted radio frequency generator package; an external use, rf transmitting coil; a surgically implanted rf receiver coil; an integral passive circuitry; surgically implanted stimulating electrodes mounted on silastic; and a shoe-heel mounted switch which activates the rf generator when the patient "steps off" with the affected foot. The implanted stimulating electrodes, receiver package, and their connecting wire appear to function satisfactorily; however, the wire extending from the heel switch to the rf generator package interferes with ambulation and is a cosmetic liability. The researchers prefer to use a wireless link to replace the hard wire link between the two points. The wireless link should require little or no battery power and be mounted in the heel of an ordinary shoe. Results of the NASA Data Bank search proved to be used merely as background material. A Problem Statement was prepared and submitted to NASA for approval to disseminate to research centers. Further discussions with the problem originator redirected concentration to electrodes for the stimulator (see RNV-33).

PROBLEM RNV-22 *Overload Protection for P.M./D.C. Motors Used in Orthotic Devices*

Researchers have developed special powered orthotic devices for paralyzed patients. A storage battery is mounted under the wheelchair to drive these small unit motors. The motors sometimes stall and burn out because the busy researchers have not developed electrical overload protection for them. A suitable means is required for protecting small, permanent magnet DC motors against excessive stall or blocked rotor current.

Two references to applicable technology were identified from NASA special publications. Information has been requested and will be evaluated for the problem originator.

PROBLEM RNV-23 *Analysis of Human Motion Patterns*

Human motion pattern studies have been made on patients who have difficulty in walking. Data are gathered to plan corrective surgery and to refine improved bracing techniques. "Normal" motion or gait patterns need adequate and convenient definition. Techniques are required for correlating and analyzing acceleration data generated at selected body sites. The objective of the data is to clearly identify normal motion patterns and determine timing, manner, and degree to which abnormal motion patterns differ from them.

Evaluated multiple-literature search data were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The team was contacted by a hardware fabricator who indicated he had a suitable triaxial accelerometer and was interested in developing this medical product line in cooperation with the program.

PROBLEM RNV-24 *Anticipatory Reference in Rehabilitation Medicine*

Measured electromyographic potentials may determine restoration progress of muscles in paralyzed or partially impaired patients. These voltages, however, will be meaningful only if the imposed degrees of stress and motion are repeatable. An anticipatory reference generation method is required to permit a patient to move a limb or perform a physical function in "time" with a rate or speed reference.

Information on Medtronic stimulation equipment and reference material by McNeil and Wilemon were forwarded to the problem originator together with the results obtained from a search of the NASA Data Bank.

PROBLEM RNV-26 *Angle Measurement in Knee Prosthetics*

The physician assesses conditions and capabilities of particular muscles and muscle groups by measuring muscle potentials developed under repeatable degrees of static and dynamic stress. A simple method is required for repeatedly measuring the angle between the upper and lower parts of the leg, relative to the knee joint. This is a cam-type joint instead of a pin-type joint.

PROBLEM RNV-28 *Accelerometer for Human Motion Studies*

Human motion pattern studies have been made on patients who have difficulty in walking. The results are used to plan corrective surgery and to refine improved bracing techniques. "Normal" motion or gait patterns have not adequately or conveniently been defined. It may be possible to evaluate and diagnose orthopedic problem cases in an "on line" manner with proper data acquisition and analysis. Small, light, and rugged triaxial accelerometers are needed.

A commercial source of applicable equipment was retrieved from a NASA Brief and the TUO at the NASA Ames Research Center. This source suggested that the problem originator fabricate the triaxial accelerometer from single axis units. This recommendation is being evaluated by the researcher.

PROBLEM RNV-29 *Manual Controls for Self-Propelled Vehicle (Wheelchair; Automobile)*

A research and development project provides transportation to rehabilitation patients who are able to usea wheelchair. The development of self-propelled wheelchairs has been evolutionary rather than by system design. This investigator currently evaluates transportation needs of the patient and then develops the devices. The controls for powered wheelchairs are being designed from the "systems" approach to obviate the obsolete constraints imposed by early model wheelchairs. The human-machine interface is given paramount consideration in this program in order to produce a wheelchair more suited to patient needs and comfort.

The results of a NASA Data Bank search were provided to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM RNV-30 *Power System for Wheelchair*

This is part of the overall program for developing various types of self-propelled devices in patient transportation. The investigator specifically is working on the development of a self-propelled wheelchair. He considers all bed-chair-automobile interaction problems for a wholly compatible transportation system. Design and performance data are needed concerning fuel cells for electric power supply and also for high energy, rechargeable, dry-storage cells. A wet cell could be acceptable if the unit is nonspillable.

The results of a NASA Data Bank search were provided to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM RNV-31 *Patient Supporting Couches*

The main development has been evolutionary for suitable patient transportation and supportive devices such as wheelchairs, stretchers, hoists, cars, etc. Little consideration has been given previously to compatibility of the anatomy of the patient with the chair, couch, or bench. Little or no effort was devoted to psychological or physiological patient comforts. The development of all of the devices has disregarded the man-machine interface. Wheelchairs were built to minimize weight or to foldup conveniently for storage. Only superficial considerations were given to fitting the chair to the anatomy of a patient. The investigator's engaged in research to evaluate the supportive-cushioning needs of the patient and design them into prototype equipment construction. He is evaluating overall patient transportation needs with a "systems" approach. He includes all factors affecting the patient in the bed, chair, and automobile. He requests NASA-developed technological support to facilitate design of seats and couches. They should support a patient in the supine position (lying on his back), erect position (sitting up), and intermediate positions between these two. The results of a NASA Data Bank search were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM RNV-32 *Measurement of Energy Expended in Walking*

This investigator is developing an improved means of diagnosing disorders of gait and evaluating "quality of walking." Gait patterns can be analyzed, appropriate diagnoses made, and corrective surgery or improved bracing techniques can be implemented through information gained from the computer, if proper data acquisition and analysis of human motion patterns are available. The researcher has taken the first steps toward realization of "on-line," computerized evaluation and diagnosis of orthopedic cases and problems. Gait motion studies have been made for patients with various disorders of gait. Motion patterns of normal subject also will be studied. A method for measuring the energy expended by a patient as he walks a certain distance is needed.

The results of multiple searches made to identify relevant NASA-developed technology are being evaluated by the problem originator.

PROBLEM RNV-33 *Nerve Stimulator Electrode for Stroke Patients*

Hemorrhage, thrombosis, and embolism are lesions of the brain which produce apoplectic stroke in hundreds of thousands of victims annually. The condition is marked by coma which is followed by paralysis. Some stroke victims fully recover while others never fully regain use of their extremities. "Dropfoot" is one such condition and refers to a sharp dropping down of the foot when the knee is raised as if to take a step. This makes walking very difficult. The stroke damaged brain fails to send the appropriate signal to the still functional muscle which ordinarily would raise the foot parallel to the floor as required for taking a step. This researcher assists dropfoot patients to walk normally by providing electrical stimulation to the peroneal nerve (one of the nerves near the knee). The Peroneus brevis, Peroneus longus, and related muscles are induced to contract and elevate the foot to the parallel walking position. The researcher needs an implantable electrode for stimulating the peroneal nerve.

Advanced NASA technology on electrode development was furnished to the problem originator while a search for a suitable electrode is in progress.

PROBLEM WVA-1 *Fluid for Foot Pressure Indicating Device*

The problem originator designed and built a pressure indicating device for mounting in the sole and heel of a shoe for a prosthetic leg. Water was used as the hydraulic fluid of the transducer–fluid line-bellows system. Water is unsatisfactory because it permeates the adhesive potting material. A fluid is needed which must be compatible with aluminum, polyurethane potting material, and tygon tubing. It will be used for filling a foot pressure indicating device.

Results of a NASA Data Bank search were forwarded to the problem originator. The team requires further comments from the researcher before searching further in the problem area.

ARTIFICIAL ORGANS AND ORGAN ASSIST DEVICES

PROBLEM GIT-8 *Biocompatibility of Materials by the Application of Electric Charge*

The researcher needs a method for applying an electric charge to artificial organs test materials within a closed fluid system. He specifically is attempting to quantitatively determine characteristics of materials to be used as artificial arteries and veins while they are under the influence of an electric charge. He places materials in the blood stream, applies an electric charge, notes the flow characteristics, and then checks for clot formation as he studies the relationships between electric charge effects formation.

Relevant aerospace literature dealing with electric charge effects on blood clotting was retrieved and provided for the problem originator.

PROBLEM GIT-1 *Pulsate Flow in Elastic Tubes for Analysis of Biocompatible Materials*

The problem originator is studying fluid dynamics in elastic tubes. The researcher specifically determines selected, flexible-tube material characteristics under laminar and turbulent flow conditions. This study is related to analysis of the blood-tube interface of biocompatible materials.

Twenty relevant citations were retrieved from the search of STAR and AIAA abstracts. They were furnished to the problem originator and the team is currently exploring other technology for possible applicability to the problem.

PROBLEM GLM-21 *Steady Convective Dispersal in Parallel with Developing Diffusive Dispersal as in Blood Capillaries*

Convention and diffusion act in parallel as two flow mechanisms to disperse dye which is introduced into a stream flowing through a tube in laminar fashion. Theoretical formulations have been made and verified experimentally for dye delivery in the simple convective case. Diffusive effects are magnified in capillaries when flows are very slow and the tube cross section is small. Dye is axially transported in concentric annuli by convection. Dye also is radially transported by the diffusive mass transport mechanism. The pattern of axial dispersion and dye delivery from the tube effluent have been theoretically formulated and experimentally tested for this problem. This latter case holds when the ratio of tube length (L) to center velocity (V_0) greatly exceeds the ratio of the tube radius squared (R^2) to 14.44 times the diffusion coefficient (D). Steady convective dispersal occurs parallel with a developing diffusive dispersal, however, in the early stages of tube washout. In such a case, the ratio L/V_0 is not far removed from the magnitude of $R^2/14.44$ D. Rich and Goodman show illustrations of solutions for two known cases; the intermediate case obviously lies between the two graphs they present. The intermediate case has been considered and numerical solutions were presented, but the application has been restricted. A theoretical solution for the intermediate case has not been established. A solution for this case is needed.

The results of a search of the NASA Data Bank were forwarded to the problem originator.

PROBLEM GLM-20 *Continuous Lymphocyte Destruction Under Sterile Conditions*

Immune-protective mechanisms of organ transplant candidates must be suppressed to avoid destruction of transplanted organs. A method is needed to selectively destroy the human lymphocyte functioning without disturbing the salty, aqueous solution of proteins and the emulsion of fat globules in the blood. The destruction process should be continuous, rather than a batch kill process. Destroyed lymphocytes should remain in the blood stream to avoid alarming the system to further production of the cells.

The results of a NASA Data Bank search were forwarded to the problem originator. Radioactive sources of ionizing radiation and extra-corporeal irradiation of blood were discussed and commercial devices were suggested as several approaches to the problem. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The problem originator does not favor two responses to the Problem Statement which suggested ionizing radiation. Mr. Emanual Rind, of the NASA Langley Research Center, sent two articles on beta bracelets. Mr. H. H. Grimes, of the NASA Lewis Research Center, also responded and the accumulation was furnished to the problem originator. Knowledge of a continuous blood centrifuge recently was received from the National Cancer Institute. The team has requested information on this technology for possible application to the problem area.

PROBLEM BLM-14 *A Compound Conduit for Use with Chronically Surviving Animals*

A compound umbilical conduit providing 2 electric leads, 2 pneumatic lines, and 6 flexible hydraulic lines to power and monitor an artificial heart implanted within an animal is needed by the investigator. The umbilical should be approximately 5 meters and is limited to a thickness of about 1 cm by the space between the animal's ribs. Quick-disconnectors on both ends of the umbilical should provide swival action to avoid kinking when the chronically surviving animal moves around. The two pneumatic lines will operate with a pulsating flow approximating 0.1 liter per second (CO_2 pressure/vacuum) at -5 and -2 psig, respectively. The six hydrostatic coupling columns will not receive appreciable flow. One of the electric leads will furnish ECG information, and, therefore, must be well shielded to reduce pickup of interference on the 1-mv source impedance ECG signal.

Results of the NASA Data Bank search were provided for the problem originator. All retrieved information proved to be of interest and one of the ten documents proved to be directly related to the problem. A Problem Statement was prepared and sent for approval by NASA to disseminate to research centers. The Research Triangle Institute and Midwest Research Institute cooperated with this team and furnished information on similar problems which was sent for evaluation to the problem originator. NASA Tech Brief 70-10109 described a quick-disconnector which appears to offer a solution to the problem. It will require reengineering before it can be directly applied to the problem and it has been submitted as a potential applications engineering candidate.

PROBLEM BLM-13 *Nonthrombogenic Biomedical Material Suitable as a Blood Interface*

Nonthrombogenic biomedical material suitable as a blood interface is needed by the problem originator. This material must be noncarcinogenic to be suitable for processing into various configurations for surgical implantation. A form of carbon developed by a considerable aerospace research effort was considered to be a possibility for these unique medical requirements.

Results of a search of the NASA Data Bank were furnished to the originator. The NASA Lewis Research Center provided information regarding use of alloys for implantation (hip replacement) and this also was furnished to the researcher. Ten samples of various configurations of special biocarbon materials were obtained in addition to the information and they were sent for evaluation to the problem originator.

PROBLEM UTM-20 *Use of Critical Path Management Techniques for Artificial Organ Development*

Many facets of a large-scale, research and development, artificial eye production program must be carefully planned to avoid staff turnover, testing procedure, and efficient programming losses. A well-organized program is needed to best utilize funds and manpower. Extensive, critical-path management technology is required.

A NASA Data Bank search is being made and the newly released NASA Tech Brief *System Availability Management Technique for Reliability and Maintainability Analysis* is being evaluated for possible application to this problem area.

PROBLEM UTM-1 *Physiologic Data Handling Systems Approach*

The problem originator is establishing a data acquisition and reduction center in an artificial heart test and evaluation facility. The facility will acquire large amounts of data from varied sources. The artificial heart or heart assist device will be tested for its electrical and mechanical properties. It will be subjected to environmental tests, evaluated in mock circulations, physiologically evaluated in animals, and finally implanted in humans. The physiological parameters will be monitored during surgery and a 24-hr monitoring will continue while the animal's condition is being evaluated for many weeks. The human patients necessarily will have to be monitored later. Some of the in vitro tests must be continuously monitored over long time periods for failure analyses. Automatic control of electrical and mechanical tests are included in planning. Guidance technology is needed concerning interfacing a large number of analog variables to the computer. Continuous monitoring of physiological parameters, methods of real time data reduction, file structure of data storage, methods of retrieval, automatic control of failure tests, and automatic determining when a failure either has occurred or may occur are facets of this same problem.

A copy of NASA Tech Brief 69-10720 was furnished to the problem originator with its information on transmission of medical signals for computer analysis for evaluation. The team is negotiating for approval of a visit by the problem originator to the Manned Spacecraft Center where he can discuss their system of handling physiologic data. A Problem Statement was prepared and sent for NASA approval to be disseminated to research centers.

PROBLEM UTM-2 *Microminiature Pressure Transducer*

Control systems are required to sense vital physiological functions and control operations of ventricular assist devices developed in artificial heart research. The problem originator needs an inexpensive pressure transducer to monitor ventricular pressure at the site of blood removal. Pump overpressures can be eliminated by zero crossing detection.

Results of a search of the NASA Data Bank was provided to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM UTM-3 *Proton Magnetometer for Use as a Flowmeter*

Flow studies of the coronary arteries and peripheral arterial system are part of the research and development of artificial hearts. Ultrasonic and electromagnetic techniques and devices presently are limited to measuring flow in larger arteries because of transducer size constraints. The problem originator requested technology support for nuclear magnetic-resonance techniques for measuring flow in liquids. He is particularly interested in the supporting signal condition which is necessary to acquire and display the information.

The results of a NASA Data Bank search were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM UTM-4 *Detection of Blood Clot Formation in Artificial Arteries by Pulse-Echo Techniques*

The ability of biocompatible materials to resist clot formation on their blood contacting surfaces is part of artificial heart research. The problem originator will use the pulse-echo technique to investigate a variety of such materials. He is seeking technology from NASA concerning nondestructive techniques to test and measure thickness to 0.1 mm.

The results of a NASA Data Bank search were provided to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The team is investigating work done at the NASA Goddard Space Flight Center for possible application to the problem area.

PROBLEM UTM-6 *Stress Analysis of Artificial Heart Valves*

Better operation of the heart by artificial valves may be possible when they are used to replace those in patients with heart valve disorders. Artificial valves have failed after prolonged use. Researchers are therefore seeking better valve design and durable materials to further improve artificial valve operation and durability. The problem originator will perform photoelastic stress analysis of sphere, disk, and leaflet configurations of sample materials to determine optimum heart valve materials and configurations. To properly analyze the samples, 2- and 3-dimensional photoelastic methods are needed.

The problem originator is seeking NASA-developed technology to assist in this analysis problem. He also needs technology on transmission polariscopes to analyze slices taken from the models. The results of a NASA Data Bank search retrieved four applicable NASA Tech Briefs and the address of a commercial vendor of a transmission polariscope. They were forwarded to the problem originator.

PROBLEM UTM-7 *Chronic Electrode Implantation Techniques for Artificial Eye Research*

A TV camera is being developed for use as an artificial eye. It will be wired directly into the brain. Many problems exist in the formulative stages of the development. Basic research is needed to define neural and electrical parameters to successfully interface the TV camera with the brain. The developer requested NASA-developed technology relating to chronic implantation of electrodes and materials. They must remain relatively inert when subjected to long-term exposure in body fluids and tissue.

Carbon electrode data was retrieved from a NASA Data Bank search and was furnished to the problem originator for evaluation. His comments are needed before proceeding to make a final transfer report. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. Negotiations are in progress to provide samples of biocompatible carbon materials.

PROBLEM UTM-8 *Biomechanical Analysis of Biological Materials*

Investigators must know the biomechanical characteristics of bone, soft tissue, arteries, and muscle to better define requirements of materials for developing an artificial heart. He requested theoretical and experimental NASA methodology relating to the characterization of materials in general and specifically to characterizing of biomaterials.

Results of a NASA Data Bank search were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM UMM-1 *Pressure Transducers for Capillary Pressure Studies*

The problem originator measures capillary blood pressure in the kidney and other organs. He intends to apply enhanced organ understanding to organ transplant capabilities. He requires microminiature pressure transducers which can be attached to a micropipette in order to cannulate the capillary to measure pressures in the range of 5 mm Hg. The transducer should have at least 10-Hz frequency response. The diameter of the transducer should be between 1 and 3 mm.

Shortly after this problem was accepted, it was transferred to another Biomedical Applications Team.

PROBLEM GIT-6 *Friction and Wear Characteristics of Compatible and Noncompatible Materials in Artificial Organ Research*

Biocompatible, artificial-organ fabricating materials also must function in the internal body environment for long periods of time. The problem originator therefore is evaluating friction and wear characteristics of the various materials to be used in designing and testing of organ-assist devices. The researcher currently is primarily interested in stainless steel and other metals which have demonstrated biocompatibility. He has requested NASA-developed technology relative to any compatible and noncompatible sliding contact materials.

Team evaluations and the various abstracts retrieved from a search of the NASA Data Bank were furnished to the researcher.

PROBLEM GIT-7 *Blood Coagulation Effects Induced by Nonionizing Radiation in Artificial Organs Research*

Sundry factors must be considered in the process of designing and testing artificial organs if the devices are to be of highest reliability. The problem originator seeks to determine if nonionizing radiation promotes blood coagulation in normal subjects. The interest extends to whether or not the effects ultimately are accentuated on subjects who have artificial organs implanted. He felt that NASA had considerable experience in the area of nonionizing radiation and requested available technology relating to this hematology question.

Results of a multiple search of the NASA Data Bank were furnished to the problem originator. Follow-up activities concerning the deleterious effects of nonionzing radiation and relevance of technology supplied are in the offing in succeeding areas of expanded investigation.

MENTAL HEALTH

PROBLEM GVA-4 *Electrostimulation Devices and Electrodes for Psychiatry Research*

The problem originator is treating alcoholic and homosexual patients with various electrical signals. Various inducements-to-response are presented via a slide projector. A shock may not be applied or may be applied when a response appears, depending upon the experiment. Electrostimulators and electrodes are needed for this psychiatric research treatment of alcoholics and homosexuals. Electrodes presently used in this experiment are unsatisfactory for several reasons. They are restrictive, fragile, uncomfortable, and restricted in signal types by their function generators.

NASA-developed, improved electrostimulation devices were retrieved from aerospace literature search and this relevant information was furnished for evaluation to the problem originator.

PROBLEM CAP-1 *Apparatus for Telemetering GSR in Natural Social Settings*

A small, reliable device is needed to acquire and transmit the galvanic skin response (GSR). The circuitry must feature high common mode injection and be compatible with an acceptable GSR electrode. The electrode must be adaptable to long-term use (24 hr or more), be free from motion artifact, and be small enough to be comfortably applied to the instep of the foot. It should be relatively easy to fabricate or be available at reasonable cost for instrumentation of large numbers of individuals. The apparatus will be worn or carried by adults engaged in activities characteristic of natural social settings such as the home, school, or a hangout.

A NASA-developed, miniature biopotential telemetry system and a copy of Biotelemetry Equipment Sources were retrieved from a search of NASA literature and were forwarded for evaluation by the problem researcher. NASA document SO 5054 also was forwarded for his evaluation. The problem was considered a potential transfer based upon NASA Tech Brief 66-10624. A potential transfer report was prepared and submitted to NASA. The problem was submitted as a candidate for applications engineering to complete the transfer. The problem was inactivated as of July 1970.

PROBLEM CAP-2 *Galvanic Skin Response Electrodes for Long-Term Application on Human Subjects*

The investigator requires suitable electrodes for taking the galvanic skin response (GSR) of human adults. The electrodes must be applied for long-term periods (24 hr or more) without impairment of sensitivity. They must minimize production of motion-induced artifacts. The electrodes must be small enough to be comfortably worn in the plantar region. Electrodes should be reasonable in cost and relatively simple to install.

One of the articles retrieved from a search of NASA literature appeared particularly applicable to the problem. NASA TN D-3414 "Dry Electrodes for Physiological Monitoring" NASA Flight Research Center describes a method for very rapid spray application of a conductive mixture onto the skin as electrocardiogram electrodes. NASA Tech Brief 64-10025 on improved electrode techniques was forwarded to the problem originator. The problem was considered a transfer and a transfer report was submitted to NASA. This problem has been inactivated.

PROBLEM CAP-3 *Noncomputerized Reduction of Data Recorded Via Conventional Polygraph Techniques*

The problem originator requires a noncomputerized technique to rapidly and economically reduce data recorded on the conventional Beckman Type RM polygraph strip chart. A digital multimeter arrangement used in conjunction with the oscillograph pen output was considered a likely possibility. The level of the telemetered galvanic skin response (GSR) could be arranged in four or five categories, such as high, medium, low, or none, on a regular time-sampling basis. Recording each time that a response occurred above a certain magnitude is another possibility. Small photocells could be used above the pens to trigger a cumulative counter. The researcher requested any NASA-developed technology for this purpose.

An aerospace literature search was performed. Contacts with NASA contractors also were made concerning availability and prices of suitable equipment. This information was provided to the problem originator and the problem was closed.

PROBLEM DVA-1/2 *Automated Techniques and Instrumentation for Administration and Analysis of Diagnostic Psychological Tests*

Free word association and projective testing are standard psychological diagnostic and therapeutic techniques which require considerable time for administering, scoring, and analyzing because independent, subjective judgments from several counselors are required. The investigator requested available NASA technology relating to automated administration techniques for mass screening and therapeutic tests. They will be used to objectively diagnose and treat psychological impairments. Methods and instrumentation are required to reduce and analyze large quantities of data obtained from diagnostic and therapeutic psychological tests.

Multiple searches of available aerospace literature were performed, evaluated, and sent to the problem originator. He evaluated the documents and found them relevant to his needs. Further definition of problem solution requirements is in progress.

PROBLEM SRS-8A *Acquisition and Telemetry of Heart Rate, Blood Pressure, and Blood Flow in Free-Ranging Dogs*

A "normal" and a "nervous" strain of bird dogs are being studied to determine comparisons of the physiological parameters of heart rate, blood pressure, and blood flow. By understanding the differences between the normal and the nervous dogs, the researcher hopes to apply the knowledge in understanding and treating mental illness in humans. Backpack-mounted, wireless telemetering equipment is needed. Its transmission range should be up to 1 mile. Two channels must be provided to capably handle blood pressure waveform and blood flow velocity. Implantable sensors must be usable with portable telemetry equipment. Service life of the system should exceed 1 week. A NASA-Ames Research Center telemetry information package was provided to the problem originator. Screened results of an updated NASA telemetry search were furnished to the researcher and he ordered ten of the documents. He indicated he was going to use ultrasonic doppler equipment to measure and telemeter blood flow information. A copy of RNV-11 *Telemetry of Body Kinesiology* was retrieved and sent to the problem originator. He successfully implanted transducers surgically around the aorta and coronary arteries and obtained good coronary blood velocity records. This telemetry system proved to be noisy and severe errors were produced when the transducers failed to properly perform in vivo.

A team member accompanied the problem originator and they visited Dean Franklin and other members of the Scripps Institute staff. They discussed ultrasonic doppler methodology for measuring blood flow velocity. They also discussed telemetry techniques and specific equipment functions. Additional current technical information on performance of the ultrasonic flowmeter was retrieved and sent to the problem originator together with requested information on the Electronics Research Center Tunnel Diode Pressure Transducer. He has reported that the device may prove to be useful in measuring blood pressure. A technology transfer has been claimed for this problem.

PROBLEM SRS-8B *Methods of Signal Categorization*

Electrocardiograms from two strains of dogs are being obtained. A suitable technique for quantifying visible differences between them is needed.

Results of a search of the NASA Data Bank were furnished to the problem originator. Referenced information was not immediately used because the search project had not progressed to the point that signal categorization methods were required. A Problem Statement then was prepared and sent for NASA approval to disseminate to research centers. Two responses have been received to the Problem Statement. They have been acknowledged, studied, and forwarded for evaluation to the problem originator. Copies of these search results and the Problem Statement were furnished to the Biomedical Applications Teams at the Research Triangle Institute for their use in possible application to a similar problem.

PROBLEM PVA-4 *EEG Electrode Holders*

The researcher needs a convenient method for holding and repositioning EEG electrodes in performing various clinical experiments. Information was furnished concerning related work in progress at the NASA Ames Research Center. The problem originator requested available NASA technology which is clinically applicable to EEG electrodes and techniques for repositioning of electrodes. A search of aerospace literature is in progress.

DETECTION AND TREATMENT OF HEART DISEASE

PROBLEM GIT-2 *Charged Test Object in Blood Substitute for Clot Formation in Cardiovascular Research*

The problem originator is studying the relationship between clot formation and electrical charge. He has requested available NASA technology which relates to charges and clot formation. The researcher plans to electrically charge selected materials placed into the flow stream of a blood substitute, and then observe phenomena and determine the interrelationships within the system.

A report of available in-house information and results of a search of the aerospace literature currently are being evaluated by the problem originator.

PROBLEM GIT-3 *Flow Fields Around a Sphere for Clot Formation Studies in Cardiovascular Research*

Upstream-downstream flow characteristics about a *sphere* are being measured as part of an overall research and design program to produce prosthetic heart valves. The researcher primarily requires suitable materials and techniques for charge-flow investigation of clot formation in blood. The investigator hopes to be able to monitor formation of clots on various materials having different charges.

A small number of pertinent retrievals were available from aerospace literature searching. The team is waiting for an evaluation from the problem originator.

PROBLEM GIT-4 *Determination of Blood Clot Thickness in Cardiovascular Research*

The researcher is defining and optimizing materials for artificial hearts and veins. He vitally needs techniques to be used in measuring formation and thickness of blood clots in blood vessels. They will be used to monitor formation, adhesion, growth, and sluffing of blood clots in biocompatible materials. The instrumentation must be able to discern 1- to 2-mm thickness of blood clots.

Thermal or pulse-echo techniques were considered applicable to this problem. Pulse-echo and ultrasonic techniques were considerably emphasized in a search of available literature which was described as resonably complete.

PROBLEM GLM-19 *Measurement of the Velocity of Myocardial Contractions by Noninvasive Means*

The ill-defined characteristic of myocardium contractility refers to several aspects of the act of shortening myocardial muscle. Methodology is needed to detect the velocity of motion of the heart wall without application of intravascular media or surgery. The measurement or observation ideally should parallel the method used by the physican as he listens to heart sounds with the stethoscope. The problem originator requested available NASA technology relating to the pulse-echo and Doppler detection methods which use ultrasonic or similar energy.

Results of a search of the NASA Data Bank were screened and forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. Four responses to this inquiry have been received, acknowledged, studied, and forwarded to the problem originator. The team arranged for the problem originator to borrow Kubichek Impedance Cardiography equipment from the NASA Manned Spacecraft Center as recommended by Mr. R. R. Smylie in his response. The equipment has been received and the researcher is preparing to test it in his laboratory.

PROBLEM DLM-6 *Measurement of Respiratory Parameters of Patients Suffering from Cardiovascular Disorders*

Related physiological parameters are considered important measures of the severity of cardiovascular disorders in humans. Respiration is one of such functional parameters. The investigator primarily measures respiratory rate and secondarily measures tidal volume. Treadmill and bicycle testing requires the sensors to be of low resistance and avoid interfering with activities of the subject. The investigator requested available NASA technology relating to this problem.

The results of the search of available aerospace literature were combined with added materials and forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The problem was submitted as a potential transfer on the basis of material retrieved from the search. Evaluation from the problem originator is awaited before finalizing the transfer report.

PROBLEM DLM-7 *Monitoring of Chest Wall Vibrations Related to Cardiac Activity*

Related physiological parameters are considered important in measuring the severity of cardiovascular disorders in humans. Measurement of chest wall vibrations related to cardiac activity at rest and during exercise is one of the parameters of interest. The investigator needs an instrument to measure the parameter without serious impediment to activities of the patient. The instrument frequency response should be from DC to approximately 2000 Hz. This problem investigator has requested available NASA techniques or devices relating to his problem.

The results of the search of available aerospace literature were combined with added materials and forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. NASA technology was identified which met the requirements of the problem originator during a team visit to a NASA center. The specifications and source from which transducers could be obtained were then forwarded to the problem originator.

PROBLEM DLM-8 *Temperature Measurement by Telemetry of Patients During Exercise and Occupational Activities*

Comparison data on normal subjects vs subjects suffering from cardiovascular disease are important when evaluating functional response. The investigator measures body temperature rectally or measures it on the

eardrum and telemeters the data to a tape recorder. The telemetry package need not be implanted, but it must avoid interfering with activities of the test subject. The problem originator requested NASA technology to help him with his problem.

A search located a NASA contractor who has recently developed hardware exactly fitting the researcher's needs. A copy of the NASA report will be furnished to the problem originator as soon as it becomes available.

PROBLEM BLM-21 *Artificial Membrane Interface*

The investigator is developing a mechanical (artificial) heart in his study of electrophysiology of the heart. An observed electrical phenomenon relative to artificial membranes may be pertinent to this investigation. The investigator needs to know the underlying physical process involved in the phenomenon in order to proceed farther. The phenomenon being studied is that of the Oswald Electric Heart. It is a globule of Hg in a beaker of H_2SO_4 which contains a minute quantity of $K_2Cr_2O_7$ that colors the acid a light yellow. A fine wire or needle is in point-contact with the mercury but is otherwise electrically insulated from ambient environment. The mercury globule pulsates with rhythmic waves of excitation at regular intervals in this configuration. This gives approximately the same appearance as a beating biologic heart. The problem originator is researching the reactions which occur, the energies produced, and the basic mechanisms involved. He requested available NASA technology to assist him with this problem.

Results of a NASA Data Bank search were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM BLM-11 *Flexible Material for Connecting Electrical Stimuli to Nerves Without Damage*

The investigator requires a soft, flexible, biologically inert, conducting material to electrically connect a lead from an implanted cardiac pacemaker with a surgically exposed carotid sinus nerve. The connection provides electrical stimulation of the carotid sinus nerve to relieve crippling chest pain associated with angina pectoris, which results from overworking the heart. The electrode must be a good conductor, be biologically inert, and be suitable for long-term implantation (at least 5 yr).

Screened search results from available aerospace literature were sent to the problem originator. Mr. Salvador Rositano of the NASA Ames Research Center has used conductive silicone rubbers for sealing gaskets in microwave horns. The problem originator is cooperating with Mr. Rositano to develop a silver impregnated silastic for a connecting electrode. Mr. Ralph Schleicher of the Southwest Research Institute suggested deposition of a metal film on silastic rubber to form the electrode. The technique is now under study by Mr. Roy Clark of the NASA Langley Research Center. He is a specialist in film deposition. Mr. Clark tentatively has suggested attachment of the electrode by cyanoacrylonitrile cement rather than by suture. He presently is awaiting photos and sketches of the present electrode to aid in his study. Information on the configuration of the present electrode has been forwarded to Mr. Clark. Mr. Rositano used technology at NASA Ames Research Center to fabricate several pairs of flexible, silver elastomer electrodes and has forwarded them to the problem originator for his experimentation. The NASA Ames Research Center additionally currently has developed an even more effective type of flexible electrode using platinum elastomer rather than silver. This is expected to extend the life of the electrode. A transfer report was written and it is included in the January monthly report.

PROBLEM NMA-3 *ECG Cable Take-Ups*

Small ECG take-up reels are needed for a portable ECG monitor. The monitor is maintained in the intensive care unit and is used in surgery or the emergency room as required. The 4-ft cables frequently become entangled and critical time is lost in attaching the patient to the machine. Time consumed in releasing the cables can be important to the treatment of a patient during emergencies.

The team is considering available commercial technology before disseminating the problem to NASA research centers. The commercial technology was retrieved from research of the NASA Data Bank.

PROBLEM NMA-4 *Spray-On Electrodes*

Electrodes that require little attention for as long as 1 week are needed for application to patients. ICU patients are often subject to difficult and lengthy stays. They exhibit different activity levels and this frequently loosens the leads and dried electrode paste. ICU nurses need a reliable, quickly applied, more efficient lead and electrode system.

An information package on NASA-developed spray-on electrodes was sent to the problem originator. This is expected to solve the problem.

PROBLEM NMA-5 *Cable Crimping on Simmons Bed with Hausted Rails*

Hausted bed rails conveniently require only one operation to raise them or lower them. Doctors and nurses prefer this feature, but the hinging arrangements crimp and cut the transducer cables. The problem investigator requested suitable NASA technology to resolve this problem.

The team is surveying Army, Navy, and Air Force hospitals for new approaches to this problem solution.

PROBLEM NMA-2 *Coiled Transducer Cables for Rough Environmental Use*

Beds in intensive care wards cannot always be conveniently positioned for the standard length cables necessary to operate essential monitoring units. If rails or the bed itself must be raised or lowered, cable problems arise. They fall across moving bed parts and are cut. They also lie across the patient and increase his discomfort. The problem originator needs lightweight, miniature, coiled, multiconductor cables which have braided shields and can be extended to varying lengths.

The team is searching NASA-developed technology in areas related to hospital monitoring for suitable cables.

PROBLEM UAM-2 *Heart Sounds Telemetry*

The heart sounds of convalescing cardiovascular surgery patients are monitored during mild exercise. Hard wire instrumentation is presently being used. The problem originator seeks to remove the interroom cabling and to be able to directly telemeter to the monitoring station. He, therefore, requires a heart sound telemetry unit to transfer signals from the exercise room to a monitor station.

The team provided the problem originator with a complete list of all "state-of-the-art" physiological telemetry. A NASA-developed phonocardiogram system incorporating a chest microphone will also be sent for evaluation to the researcher. The existing telemetry package with its microphone should solve this problem.

PROBLEM UAM-1 *Capacitive ECG Electrodes*

The problem originator monitors ECG and heart sounds with the same transducer during continuing research on heart disease detection and treatment. Reduced numbers of electrodes save time during attachment and reattachment for the data acquired. He requires capacitive electrodes to simultaneously measure ECG and heart sounds and reduce possibilities of shocking the patient, since no current flows in the body with capacitive electrodes.

A search of the NASA Data Bank retrieved materials for various ECG electrodes and applications techniques. A large amount of in-house data also was available. The problem originator has been advised of NASA technology available to solve his problem.

PROBLEM GVA-5 *Computer Analysis of ECG Wave Shapes*

Blood pressure, heart rate, and ECG are monitored once each minute for cardiovascular surgery patients having myocardial infarcts. The problem originator seeks to computer analyze the ECG and continuously

measure the waveshapes of the T-T and S-T periods. He requested NASA technology for methodology to monitor and analyze the ΔT and the ΔS-T periods of the ECG waveshape.

Relevant technology was retrieved from a search of NASA data on computer analysis of ECG waveshapes. Available material was forwarded to the problem originator for his evaluation of applicability to his problem area.

PROBLEM GVA-3 *Automatic "R"-Wave Detector*

An automatic R-Wave detector is needed by surgeons and the hospital staff for their intensive care facility. Threshold adjustments on heart rate equipment change throughout the patient's stay and these adjustments must be individually set with current methodology. The problem originator needs an automatic R-Wave detector that requires no threshold adjustment to measure heart rate. Capability to fabricate the unit is available if NASA-developed specifications on relative technology can be located.

A likely solution was retrieved from a search of the NASA Data Bank. Details have been provided to the problem originator for an automatic R-Wave detector.

PROBLEM BVA-4 *Portable ECG Telemetry Receiver and Chart Recorder*

The problem originator is looking for a method to monitor the ECG of his patients during his hospital rounds without disturbing them while they are engaged in various convalescent activities at various locations. He needs a portable, hand-carried ECG telemetry receiver and chart recorder. The unit should be lightweight and comfortable to carry for short periods of time.

The team performed a search and identified several sources for portable telemetry receivers. These data were made available to the researcher.

PROBLEM BVA-3 *Attachment Techniques for ECG Electrodes*

Researchers on heart disease detection and treatment need better electrocardiogram electrode attachment techniques for use on patients during exercise. Skin resistance, sweating, and layer thickness pose electrode-skin interface problems in retaining signal integrity for the ECG of cardiovascular patients undergoing controlled testing. Lightweight and rugged electrodes and leads are needed.

Current NASA ECG electrode technology was retrieved for evaluation by the problem originator after a search. Evaluation of many alternative systems is necessary since the researchers require various suitable hardware and application techniques.

PROBLEM AVA-1 *Chest Wall Movement Transducer for KCG Measurement*

The problem originator wants to use the same transducer to measure KCG and heart sounds. A homemade bellows transducer presently is available to the researcher and it measures only the KCG. The researcher believes better diagnosis can be made if the combined KCG and heart sounds are incorporated with the ECG and chest wall displacement. He requires a chest wall transducer that is linear out to 3 Hz. It must have a contact point radius of 0.25 in. or less and a sensitivity range of 0.001 to 1.5 inch.

Several approaches to the problem were retrieved from a search and they are being evaluated as a possible technology transfer.

PROBLEM BVA-1 *X-Ray Transparent Electrodes and Leads*

The problem originator wants to monitor extensive ECG information while obtaining x-ray, dye-study information on the cardiac circulatory system. ECG leads and electrodes presently negate dye studies

effectiveness because they mask the arteries and veins. Interference of the smallest of wires can be very misleading since the prime interest lies in the circulation of small veins and arterioles. The researcher requires essentially x-ray transparent ECG leads and electrodes.

Several interesting approaches to this problem were retrieved from a NASA Data Bank search. Tech Brief 68-10363 contained additional information about an electrically conductive film which is transparent to radiation. This material hopefully may be fabricated into suitable x-ray transparent electrodes.

PROBLEM RNV-27 *Intramyocardial Electrode*

The problem originator is researching a mathematical modeling of the electrocardiogram. He needs to measure intramyocardial electrical impulse maps (voltages at sequential layers of tissue in heart muscle) to make realistic assumptions about the heart as an electric field generator. He requested assistance from NASA-developed technology to obtain a suitable electrode or a design to fabricate an electrode for this purpose.

A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The NASA Biomedical Applications Team at the Research Triangle Institute has provided information on a similar problem and this was sent for evaluation to the problem originator.

PROBLEM SNM-5 *Implantable Telemetry System for ECG*

The researcher requires a small, implantable telemetry system to continuously transmit electrocardiographic data from chronically surviving primates who have received cardiac transplants. The system must be biocompatible, must have an effective range of approximately 20 ft, and must have a useful life of about 60 days.

A NASA literature search retrieved a document with circuitry information about a subminiature biotelemetry unit for remote physiological investigations. The problem originator is using details from this circuitry to fabricate an applicable working replica of the NASA model.

PROBLEM SFM-6 *Small Wide-Band Microphones for Sensing Heart Signals*

A researcher believes microphonic sensing techniques may be as reliable and valid as current traumatic procedures to produce human heart function data. He needs small, flat, circular microphones (1 to 2 mm thick and 1 cm diameter) and small, oval-shaped microphones to sense human cardiac sounds and pulse waves. The microphones should provide frequency response from DC to 500 Hz and connect to a moderate impedance amplifier.

The researcher was furnished a copy of Dr. Raul San Martin's Southwest Research Institute's Technology Utilization Survey of microphones. It was of considerable interest but was not a solution to the problem. Abstracts of related technical articles, available information on potentially applicable commercial devices, and the screened results of a NASA literature search were sent to the problem originator. A Southwest Research Institute engineer reviewed the problem because he is a specialist in applications for accelerometers and microphones. He recommended an Endevco Corporation microminiature accelerometer be evaluated by the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers after the problem originator advised that he had found the other information very useful but no solution to his problem.

PROBLEM UTM-19 *Electrodes for Use in Measuring the Heart Rate in Active Experimental Animals*

A researcher measures the heart rate of dogs running at a rate of 1 to 6 mph on a treadmill. He attaches electrodes to the animals and hard wire leads are routed to recording instruments. Attachments of subcutaneous, taped, or strapped electrodes have proved to be unacceptable. They fail to provide reliable data due to activities of the dogs. He requested assistance through available NASA technology in his search for suitable electrodes or electrode attachment techniques.

The problem originator was provided with data concerning spray-on electrodes and he reported this was exactly what he had been searching for. This problem was classified as a transfer and the transfer report is in preparation.

PROBLEM DVM-4 *Automatic Atraumatic Blood Pressure Measurement*

The problem originator measures human physiological parameters such as temperature, heart rate, ECG, and blood pressure. He requires a method for measuring blood pressure without penetrating the skin. It should provide a high degree of immunity to artifact caused by acoustical noise during automatic operation. The method also should resist motion artifact. An occulusive cuff may be used. The problem originator has suggested interest in the ultrasonic doppler devices.

An ultrasonic Doppler blood pressure apparatus had been developed by Southwest Research Institute for the U.S. Air Force and it was improved on a NASA funded contract. A NASA/USAF fabrications instructions document and the unit were forwarded to the problem originator. He evaluated the method as very useful and far superior to other methods. He is building his own unit from these specifications. This problem has been classified as a potential transfer.

DETECTION AND TREATMENT OF CANCER

PROBLEM SCW-5 *Technique for Recovery and Separation of Amylase from Polyacrylamide Gels*

The researcher's program centers on detection, treatment, and prevention of gastrointestinal tumors. He has encountered problems in recovery and separation of amylase (enzymes) from polyacrylamide gels.

A possible solution to the problem may be found in NASA electrophoresis technology.

PROBLEM LLV-5 *Method for Taking Repeated Biopsies of Soft Tissue Through a Single Portal*

Apparatus is needed to take repeated samples from spleen, kidney, liver, and lung tissues which are soft and relatively free to migrate. Repeated samples should be taken very near the same sites and this requires an in-dwelling cannula or similar apparatus. Several needles have been tried and found to be unacceptable.

Exceptionally few references were retrieved from a search of relevant NASA technology. The Southwest Research Institute work in the field of tissue interface studies may be directly applicable to the problem. Problem originator evaluations of currently available information were requested.

PROBLEM UFM-6 *Xeroradiography of the Mammary Glands*

Xeroradiographic mass screening tests for detecting breast cancer are being considered to reduce medical treatment costs and increase effectiveness of the screening process. A method is needed to rapidly xeroradiograph mammary glands. Mass screening of other soft tissues will follow if suitable and successful procedures are developed here. The problem originator was asked to evaluate the screened results of a search of NASA ultrasonic holography, telemetry, and other devices.

PROBLEM LVA-3 *Radioactive Cell Counting Method*

It is extremely time consuming to use microradiography to detect the amount of tritiated thymidine uptake by rapidly growing malignant leukemic bone marrow cells. It requires 7 to 14 days to expose the emulsion to H^3 beta particles and another 12 to 14 hr to microscopically count the exposed grains in developed radiographic emulsions. The procedure is a gross representation of radioactive uptake since the stem cell, monocyte, or megakaryocyte types cannot be identified. Identification of these cell types is a prerequisite to specific treatment of leukemic patients. The researcher needs a microdetector for beta particles (H^3 or C^{14}) adapted to a microscope and microlocator slide.

A Problem Statement is being prepared for sending to NASA for approval to disseminate to research centers.

PROBLEM NMA-8 *Ultrasonic Techniques to Support Radiological Therapy*

The researcher needs techniques to nondestructively measure blood flow and arterial dimensions to assist in radiological therapy. Radiological therapy administered at hospitals must frequently be undertaken without direct knowledge of the inner surface of arteries to be treated. Knowledge of flow and arterial diameter is required for accurate calculation and administration of dose.

A search of relevant NASA technology is in progress.

PROBLEM SWC-3 *Differentiation Between Normal and Abnormal (Tumor) Tissues by Using Ophthalometric Techniques*

The researcher determines differences in temperature, pressure, and flow rate of blood in the internal carotid artery and eye lesions (tumors), by applying sensitive thermistors, infrared detecting devices, and/or pressure and flow transducers. His research goal is developing improved clinical diagnostic tools for use on the 30 percent of eye tumor patients who constitute problems in diagnosis. Inadequate diagnostic techniques frequently hamper accurate diagnosis and early treatment of these cases. Improved diagnostic techniques will permit initiation of early treatment and lead to development of suitable preventive measures.

Results of available aerospace literature were sent to the problem originator. He was also provided with identification of a scientist who is researching a similar area.

PROBLEM SWC-8 *Improved Method for Computing X-Ray Depth Dosage*

The radiologist normally computes an x-ray dose distribution when administering x-radiation for such therapeutic purposes as tumor treatment. Contours are delineated which circumscribe a body area in computing dosage. The technique fails to adequately evaluate absorbed tissue doses between the contours, and generally interpolates the data. Precision and accuracy in this area frequently may be lacking. The investigator needs a computer technique to x-y plot a dose between contours at any depth.

Results of a search of relevant aerospace literature were furnished to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. A response was received from the NASA Ames Research Center which provided a possible problem solution. Evaluation is pending receipt of an x-ray dose distribution from an actual case, as requested from the problem originator.

PROBLEM SCW-7 *Improved Scan Resolution of Radioisotope-Filled Organs*

The radioisotope imaging system should produce quality images with diagnostically significant detail. Radioisotope scanning and delineation of radioisotope-filled organs for clinical diagnosis is frequently difficult. The investigator is exploring new scanning techniques and considering new isotopes which may provide greater detail or image resolution. Minimal radiation injury protection must be provided for the patient at the same time.

A search is underway for relevant NASA aerospace technology.

PROBLEM PVA-2 *Capabilities for Characterizing New Compounds Derived from Tumors*

The problem originator has isolated minute samples of labile compounds from tumors. Extremely specialized microchemical and structural analyses instrumentation and techniques are required to analyze and characterize the diverse compounds. The techniques should include ultramicro infrared, ultramicro mass

spectrometry (measuring compounds of the nature of ATP), fluorescence-phosphorescence, and interpretation of optical spectra. The problem originator has requested assistance with his problem area from available NASA technology.

A search of relevant NASA technology is in progress

ECOLOGY

PROBLEM UTM-11 *Motion Transducer for Studies on Small Animals*

Human ecology research is directed to high density population problems with symptoms of pollution, increased crime rates, civil rights disputes, riots, and increased drug abuse rates. The investigators are studying high density population responses to adverse stimuli of electrical shock, smoke, dust, crowding, and odors. The human situation is being simulated with small birds and rodents being used as models. Instrumentation is used to measure posture, position, and activity responses caused by adverse stimuli to these test animals. Posture and reaction time of head movements of a pigeon when subjected to an electrical stimulus is one type of test being used. The problem originator had been measuring posture with a handmade, 3-position mercury switch which provided no reaction time information. This switch was heavy and cumbersome. Results of the experiment tended to be nullified due to factors of fatigue, overcompensation, and breakage of its glass.

NASA Tech Brief 66-10534 *Miniature Piezoelectric Triaxial Accelerometer Measures Cranial Accelerations* was retrieved as a possible solution to the problem. The Whittaker Corporation was cited as a source to provide the accelerometers. No modification of the NASA technology is required to aid this part of the problem originator's program. This will permit the investigator more time to run field studies and provide conclusive data to the actual population crowding problem area.

PROBLEM UTM-12 *Biotelemetry for Animal Tagging in Ecological Studies*

Animal reactions to the presence of other animals in their natural habitat, plus the introduction of adverse stimuli, are used as models for human ecology studies. Ranging habits of animals, as they approach foreign objects, were determined in the initial phase. The problem originator requested available NASA technology to assist him with miniature telemetry transmitters for possible use on small rodents. The devices must be able to withstand normal environmental elements.

Results of a search were sent for evaluation to the problem originator and he was provided with commercial sources of these supplies.

PROBLEM UTM-13 *Small Animal Posture Indicator*

Human ecology research is directed to high density population problems with symptoms of pollution, increased crime rates, civil rights disputes, riots, and increased drug abuse rates. The investigators are studying high density population responses to adverse stimuli of electrical shock, smoke, dust, crowding, and odors. The human situation is being simulated with small birds and rodents being used as models. They are subjected to confrontations with others of their species to study aggressive behavior. The animals strike different poses as they react. They tend to maintain the pose until the stimulus is removed or changed. The problem originator has been visually observing the poses over an extended period of time. He requested assistance from available NASA technology.

NASA Tech Brief 68-10315 "Gimble Angle Sensor" was retrieved by the team as a proposed solution to the problem. The problem originator is using the specifications to fabricate a lightweight version of the system for use with his small animals. He feels this equipment innovation will greatly reduce man-hour effort in his laboratory so that accelerated and more meaningful field studies can be performed at their ecology preserve.

PROBLEM UTM-15 *Dust Mills for Aerosol Generation in Environmental Chambers*

Small animal models for human ecology research are subjected to various dust aerosols and their behavior reactions to these pollutants are observed. Individual or groups of pigeons, mice, and moles are placed in the environmental chambers. Dust particles are hand-injected while observations are made. The problem originator has requested available NASA technology with regard to generation of uniform particles from blocks or chunks of solid materials.

Results of a search of relevant NASA literature were forwarded for evaluation to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM UTM-16 *Catalytic Heaters for Remote Environmental Chambers*

Human ecology is being studied in a remote ecological preserve in a national forest. Randomly located small chambers provide shelter and control the environment for small animals. Access, noise, space, and light controls are present. The problem originator has not been able to control temperatures. He needs to study the temperature parameter of the experiment and requires additional heat in the chambers for correlation with other variables. He has been using catalytic heating devices because of the basic fire danger restrictions in national forests prohibiting electrical heating devices. He requested NASA-technology help with his problem.

The results of a search of NASA aerospace literature were provided to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM UTM-17 *Biotelemetry and Stimulation for Free-Ranging Animals*

Free-ranging animal models on an ecology preserve are being used for human ecology studies. The problem originator plans to stimulate the animals by radio control to elicit certain responses at prescribed times and monitor pertinent physiological parameters. He requested available NASA technology related to multi-channel telemetry systems and radio control systems to monitor and stimulate six animals.

The results of a search of NASA literature were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM LLU-1 *Fermentation Process Applied to the Handling of Waste*

The problem originator is comprehensively studying methods of handling animal wastes. He is determining the feasibility of applying a fermentation process to greatly reduce bulky wastes and permit them to be reconstituted for use as livestock feed or as fertilizers.

Results of a search of available NASA literature were sent for evaluation to the problem originator. The team is consulting with a NASA Technology Utilization Team which deals with waste management problems.

PROBLEM LLU-2 *Protein Synthesis Approach to the Handling of Waste Products*

The problem originator has requested available technology for application to his problem of protein synthesis as an approach to handling animal waste products. Feasibility of this method is being evaluated. Bulky wastes could be greatly reduced in volume and after reconstitution may be used as livestock feed or fertilizers.

A search and inquiries in this area were negative and the problem has been closed.

PROBLEM LLU-7 *An Adjustable Histamine Aerosol Generator for Pollution Studies*

The investigators are assessing the physiological effects of the characteristic smog-air pollution of large metropolitan areas. They need a method for generating a known and modifiable histamine aerosol to

investigate physiological concomitants of histamine exposure. This is used as a proxy to study the effects of smog. The required methodology must provide precise control of output aerosol-histamine concentration. It must overcome heavy histamine molecule tendencies to "fall out" of suspension before they are driven into the surrounding atmosphere. A sensing apparatus possibly could be added to the nebulizer. The sensor automatically adds make-up ingredients as required to assure maintenance of precise concentrations.

A search of available aerospace literature has been initiated. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM GLM-22 *Ear Defenders for Industrial Workers*

Continuous, interrupted, or shot-like high intensity industrial noise is injurious to hearing. The "permissible noise exposures" which have been suggested as analogous to radiation tolerance and safety regulations appear to fall short of being an adequate measure of safety. The frequency spectrum of acoustical energy extends throughout the entire normal audible range (20 to 20,000 Hz). The frequency range extends above and below the audible range in many instances. Ear plugs have been acceptable to workers. A combination of ear plug–ear muff provides more acoustical protection, however. The problem originator needs better quality sound absorbent materials. They must be convenient to shape and form. It must be comfortable to wear if it contacts body tissue. The researcher plans to generate new designs for ear plugs and ear muffs. He requested assistance from NASA technology.

Results of the search of NASA literature were forwarded to the problem originator. A Problem Statement was prepared and forwarded to NASA for approval to disseminate to research centers. Responses were received from NASA Langley Research Center and from Wright-Patterson Air Force Base.

PROBLEM USC-4 *Method for Measuring Rate of Change of Physiological Data*

Residents living near the ends of airport runways are being studied for possible hearing damage caused by aircraft noise. The researchers intend to measure certain parameters while applying selected acoustical energies via headphones. They are interested in reaction and recovery time response of subjects to noise-bursts. They are looking for a method of taking galvanic skin response (GSR), heart rate, and, plethysmographic data which will simplify data acquisition, storage, and interpretation. Assistance from NASA technology was requested for the problem area.

Results of a search were forwarded for evaluation by the problem originator. He considers several of the documents to be excellent in his problem area. The team plans a visit to the investigator to discuss future planning for solution of his problem.

PROBLEM SNM-16 *Techniques for Prevention and Control of Contamination of Food Fish Mollusks and Crustaceans*

Pollution of coastal waters is rapidly contaminating seafood supplies. Uncontrolled pollution soon will take a heavy toll among populations of human seafood supplies of fish, mollusks, and crustaceans. A practical system is needed to measure and control the pollution. A wide-range analysis approach is being undertaken on the program which has the support of eleven U.S. Congressional committees. Pollutants will be classified and identified. The contaminants expected in seafoods will be determined. Techniques will be developed for control and prevention of contamination of seafood supplies.

Four documents dealing with thermal and chemical pollution and with sensing devices were requested by the problem originator after he evaluated the results of a search of available NASA technology.

PROBLEM GLM-33 *DC Powered Proportional Temperature Controller in Biochemical Pollutant Studies*

Biochemical pollutants investigators need an instrument to sense, control, and maintain a DC-powered oven. It must control temperatures within a 0.2°C accuracy in a range from 75° to 225°C. Conventional

AC-powered units (SCR's) previously were used and they created problems of spurious noise signals in the researcher's other instrumentation.

This problem currently is awaiting results of a search of available NASA technology which is in progress.

PROBLEM SNM-17 *Measurement of Fallopian Tube Muscle Activity and Muscle Electropotential of Experimental Animals*

Extensive research into birth control has been prompted by the important population explosion control problem. New methods need to be developed which consider physiological and psychological effects of present methods. The researcher is investigating inhibition of fallopian tube activity by use of drugs as a possible answer to the birth control problem. Nonirritating sensors are needed to measure pressure, contractility, and electropotential changes. This will develop a direct method of assessing fallopian tube response to administration of a drug. The problem originator requested assistance and a search of available NASA technology was initiated.

Five documents have been retrieved and are currently being evaluated by the problem originator for possible application to this problem.

PROBLEM USC-5 *Materials for Intrauterine Devices*

The investigators need encapsulating and foundation materials for making experimental intrauterine devices. The problem originator has fabricated intrauterine devices which slowly diffuse out entrapped drugs. He now seeks to fabricate and test a wide range of intrauterine devices made from various permeable and impermeable materials. The materials must be nontoxic and resist decomposition within a biological environment.

After the problem originator requested assistance, a search of available NASA technology was undertaken. The team furnished available information and the problem originator used this information to decide on tailor-fabricating materials to fit the problem requirements. The problem will be closed.

HEALTH CARE COST REDUCTION

PROBLEM SWC-4 *Information Retrieval System for Clinical Records*

The investigator needs to retrieve information from a bank on one-half million clinical records in a medium-sized hospital having 80,000 annual admissions. He particularly desires access to information from the records relating to specific medical treatment, disease prevention, and trend identification in medical treatments. He seeks to perfect techniques for providing guidance in cryptic disease treatments by computer analysis. Sophisticated data processing equipment (IBM Computer Model 360) is on hand at the hospital but there are no software programs available for the outlined task. The problem originator sought NASA technology assistance for his problem.

A team visit to the NASA Manned Spacecraft Center provided information concerning Dr. E. C. Moseley, of the Medical Research and Operations Directorate, and his development of some general computer programs for use in the Medical Information Computer Systems (MEDICS) program. They appeared to meet the requirements of the problem. They consist of:

- Storage of Medical Records in Retrieval Form
- Retrieval of Medical Data According to Specifications
- Updating of Medical Data Bank

Action was taken to arrange for the problem originator to visit with Dr. Moseley and to obtain appropriate documentation. A potential transfer has been claimed for this problem.

PROBLEM UOF-1 *Tape Head Maintenance for Hospital Computers*

Tape heads used for measurement of ECG and EEG frequently have become inoperable at the tape head after 15 min operation. This forces shutdown and head maintenance before continuing to record the small biopotential signals. The shutdown is costly in time and lost critical data. Cooperative efforts between the problem originator and commercial representatives failed to solve the problem. He then sought assistance from NASA technology.

The problem was submitted to the Technology Utilization Officer at the NASA Manned Space Flight Center at Huntsville, Alabama during a team visit. This produced several suggested solutions to the problem. They suggested that oxide polished tapes be used and recommended that the air balance equipment be kept operating 24 hr daily to govern the environment around the tape apparatus. They suggested maintaining constant humidity-temperature relationships in the tape recorders. A transfer has been claimed on this problem.

PROBLEM USC-3 *A Secure Method for Patient/Specimen Identification*

More efficient and economical acquisition and utilization of clinical test information is needed. A suitable means for data acquisition, analysis, recording, and billing is required for automation of clinical laboratories. A secure means for patient/specimen identification is a vital need. It must be available if a high degree of automation of clinical laboratories is to be achieved. It must permit accurate and rapid marking and reading of samples. The samples may be in a variety of containers, such as glass tubes, petri dishes, etc. Plastic-tab attachments to specimen containers has proved unsatisfactory. Radioactive coding and mechanical identification, drilling or scoring also have been suggested. Many different means have been unsatisfactory to private and commercial concerns because of misidentifications and other confusions. This constitutes a major roadblock in automation efforts. The problem originator sought NASA-technology assistance for unique approaches to identifications of specimens leading to automated readout and correlation of specimen identity, test data, data analysis, and patient billings. This will provide maximum clinical laboratory benefits at minimum costs in all areas.

Little relevant technology was retrieved from a search of the NASA Data Bank. A Problem Statement was prepared and sent for NASA approval to disseminate to research centers.

PROBLEM LVA-4 *Research Facility Planning*

The problem originator is planning to build a new medical research facility which will require a multi-story building, zonal air conditioning, interchangeable modular cabinetry, and optimum flexibility of modular laboratories and training space. It must accommodate regular and part-time staff members. Research will be broad, though concentrating on biochemistry and neurophysiology.

A large number of relevant references were retrieved by the search of available NASA literature dealing with laboratory facility planning. Other reference documents were provided from an on-site, in-house search. Several documents have been requested by the problem originator. NASA developments in the fields of facility and research-facility planning should prove to be valuable in planning of future medical research facilities.

PROBLEM NMA-1 *Program to Establish Safe Electrical Standards for Patient Safety*

A means is needed to establish a comprehensive set of electrical safety standards for equipment and instruments used around patients. Doctors and hospitals are concerned about the current tolerations in equipment and instruments around the patient in surgery and the intensive care unit. A great deal of electrically powered equipment comes in contact with patients in these situations and some of it has caused problems. A limit can be set to require manufacturers to cut down on leakage current if their devices become disconnected to a ground. Standards must be set for total leakage current about patients.

Reasonable standards also must be set for instruments, beds, stands, monitoring, and therapy equipment, as well as power cords and sockets. The problem originator requested NASA-technology help in this large problem area.

Several possible leads to the solution of the problem were retrieved from a search of the NASA Data Bank. The overall solution will entail proper formulation of a program which is specifically tailored to hospitals. Further definition of the problem is underway.

PROBLEM SNM-19 *Computer-Based Health Records Systems Development*

Development of a computer-storage-and-retrieval medical records system which is appropriate for servicing the needs of a large country hospital center is underway. The researchers urgently need existing computer-based records systems to increase speed and accuracy of medical records handling. The present system is proving inadequate for the growing hospital load.

The search of NASA literature retrieved technology concerning medical data processing. The team also sponsored a Medical Information Systems seminar during July 1970 at the NASA Manned Spacecraft Center which the problem investigator attended. A significant technology transfer may result from this meeting at Houston.

REMOTE HEALTH CARE SERVICES

PROBLEM NIH-2 *Management of Remote Health Care Centers with Central Hospitals*

A quick communications link is needed between outlying clinics, mobile health facilities, and clinics in central hospitals. Follow-up maintenance care of patients is complicated because the doctors in the outlying clinics and hospital clinics do not know what treatment was given to any given patient outside of their own facility. Records transferrals and M.D. scheduling to handle highly variable patient loads are part of this same problem. The Chief of Outpatient Service requires organization of records, rooms, and personnel to quickly adjust the highly mobile loads, both within a hospital and to or from outlying clinics.

A computerized search was made of relevant NASA literature. The July published NASA Brief 70-10063 *System Availability Management Techniques for Reliability and Mantainability Analysis* is currently being reviewed and evaluated for this application.

PROVISION OF MORE AND BETTER MEDICAL/PARAMEDICAL PERSONNEL

PROBLEM DLM-12 *Automatic Circulation Control System for a 100,000-Volume Library*

Circulation has been manually handled in the past for a 100,000-volume medical library at a Southwest medical school. The manual controls are proving to be inadequate because of increasing demands for library services. A computer program to automate circulation controls is needed.

The team reviewed NASA Scan Sheets as part of the search and learned that the NASA Marshall Space Flight Center and the Army Missile Command jointly had developed a system for the scientific library at Redstone Arsenal, Alabama. The system has automated literature processing, handling, and analysis. The team was able to obtain information describing the system. Analysis of the information indicated the system can be readily adapted to other computer configurations in library environments, satisfying the maximum interchangeability factor goal of the problem originator. This system features viable operating programs for serial routing and other patron controls of book circulating, ordering, receiving, and cataloging; serials ordering, receiving, binding holdings, and routings; language controlling; and holdings inventorying. The Clearinghouse for Federal Scientific and Technical Information furnished extensive documentation for the joint NASA/AMC automated library system. This documentation is in sufficient detail for the problem originator to adapt the system to his automation problems.

PROBLEM DLM-11 *Improved Techniques for Teaching Biomedical Research*

A Southwest medical school is improving techniques for teaching biomedical research subjects. The faculty is trying to use sound films and videotape to record seminars and lectures which are presented by prominent biomedical researchers. The recorded presentations will be readily available for repeated viewings at times convenient to individual students and faculty members. Valuable, broadening, educational experiences can be preserved and used which otherwise may not be available to serve the needs of the large segment of interested individuals. The problem originator requested available NASA technology related to biomedical research to include, but not necessarily be limited to recorded nonclassified seminars, lectures, and general interest materials. They could have originally been in-house NASA presentations, NASA contractor presentations on specific projects, or mass-communications media public releases. The investigator needs to know about availability, source of supply, and retention periods for relevant, recorded materials.

A search was made of relevant NASA literature. Contacts with NASA centers have also opened up several leads. Screened data are being followed up to provide appropriate information on available audio-visual presentations for this problem area.

PROBLEM TVA-1 *Performance Evaluation of Trained vs Untrained V.A. Hospital Volunteers*

Training of volunteers has been accepted as a necessary requirement before they can be used in a hospital setting. The impact of such training on performance of routine duties by the volunteers has not been fully researched. The problem originator hopes to obtain such adequate measurements by analyzing approximately 350 supervisory ratings that were returned for a national survey of 10 V.A. hospitals. He needs a computer program to statistically analyze performance rating scale data as an integral part of the study.

A computer document *Revised Stepwise Regression Program* was ordered from COSMIC and was sent to the problem originator. The problem is presently in a closed status.

PROBLEM LLU-3 *Methods for Data Acquisition and Computer Programs to Analyze EEG and Evoked Responses*

The problem originator teaches data acquisition and analysis techniques to physicians. He specifically is interested in EEG-analysis and evoked-responses computer programs. They will be presented to medical students to simplify understanding of the sophisticated transforms of time variable EEG signals where applicable.

A search retrieved many such programs which were evaluated by the researcher. They are presently being reviewed in detail.

KIDNEY DISEASE DETECTION AND TREATMENT

PROBLEM UTM-5 *Dialysis Techniques for Artificial Kidney Research*

The present large and costly artificial kidney machines require patients to remain in the close vicinity of a permanently located machine or dialysis center. Maintenance of these machines is a considerable expense factor. Low-cost, portable machines should be made available for use by uremia patients in homes or offices and thereby increase the freedom of movements and other patient benefits. The problem originator requested available NASA technology concerning dialysis, water purification, and deionization of liquids. He also needs information and technology relating to adsorbants or converters for removing dissolved urea, uric acid, and creatine.

A manual search of aerospace literature was completed, screened, and the results were forwarded to the problem originator. He expressed interest in all of the studies, techniques, and systems, but was unable to immediately and directly use them to solve his problem.

PROBLEM UFM-1 *Rapid Quantitative Analysis of Urine Constituents*

A rapid and economical method or instrument is needed to analyze elements and compounds in urine. Diagnosis and treatment of patients are presently delayed in hospitals by the slow and costly urinalysis techniques. The problem originator must analyze urine specimens for sodium, potassium, calcium, magnesium, oxalates, urates, and urea.

Previously searched, related bioproblems provided the team with relevant and current information for this problem. This was furnished to the problem originator while the team continues to search for an economically acceptable method to solve this problem.

PROBLEM UFM-3 *Mathematical Model of Urinary Stone Formation*

Little or no current understanding exists regarding the causes of kidney stone formations. The problem originator is describing the chemical and physiological changes which occur in the kidney during stone formations. He is experimentally developing a computer-assisted model to describe how urinary stones are formed. This will lead to diagnostic techniques for prevention of the formation of such stones.

The team has initiated a computerized search of aerospace literature. The results will be evaluated and then sent to the problem originator for possible application to his problem area.

PROBLEM NMA-9 *Low Cost Dialysis Scrubbing Pads*

The researcher needs material with the approximate characteristics of Silastic, but with about one-third of its cost. Silastic scrubbing pads have been used in the hospital for dialysis of patients. Such pads are prohibitive in cost, and a more economical substitute should be provided, if possible, to lower hospital expenses.

A computerized search of NASA technology, for possible use in the problem area, is in progress.

PROBLEM BLM-16 *Measurement of Electrolyte Concentrations in Renal (Kidney) Medulla and Papilla*

A renal physiologist is investigating the microcirculation of blood in the medulla and papilla of a dog's kidney in ongoing research into kidney function and operation. He is particularly interested in the in situ and in vivo acquisition of sodium, potassium, and chloride ion concentrations obtained by inserting a minute probe into the kidney. Salt and water intake will eventually be introduced to physiologically vary the ion concentrations in the study.

A computer search of the NASA Data Bank was completed and the results were forwarded to the problem originator. This search provided interesting and useful information but failed to solve this problem. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The team visited the NASA Manned Spacecraft Center and learned that NASA-sponsored researchers were working on a similar problem. The problem originator was urged to individually contact these scientists to discuss possible approaches to the problem.

PROBLEM BLM-17 *Improved Procedure to Measure Regional Blood Flow in the Kidneys*

A renal physiologist is investigating the microcirculation of blood in various layers of the kidney in ongoing research into kidney function and operation. Rigid electrodes are inserted into the kidney with micro-manipulators while the kidney is lying in a cup outside the body during hydrogen-washout techniques. The investigator needs suitable electrodes to implant and measure regional blood flow in situ. Observations must be repeated on the animal over long periods of time.

Results of a manual search of relevant NASA technology were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The

team made a visit to the NASA Manned Spacecraft Center and obtained names of researchers. They are being contacted for suggestions in this problem area.

PROBLEM DLM-14 *Detection of Kidney Stones During Surgery*

A physician urgently needs a method or instrumentation to detect small stones in the kidney during surgical procedures. Larger renal calculi (stones) can be removed with surgical techniques. The smaller calculi are difficult to locate and remove, however, and commonly cause recurrence of the calculi problem with a requirement for repeated surgery. This increases both hazard and expense for the patient as well as inconvenience. The required technology must be accurate, reasonable in cost, relatively easy to operate, and adaptable for operating room use. Roentgenography, which has been useful in establishing the presence of large renal calculi, has been inadequate to identify the smaller calculi. Improved radiographic techniques or ultrasonics may provide applications to solve the problem.

Efforts were initiated to acquire an ultrasonic scanner to be evaluated by the problem originator. A Problem Statement was prepared in June and sent to NASA for approval to disseminate to research centers. Following approval, dissemination was made to NASA Manned Spacecraft Center, Goddard Space Flight Center, Marshall Space Flight Center, Langley Research Center, Lewis Research Center, Ames Research Center, and John F. Kennedy Space Center.

REDUCTION OF INFANT MORTALITY

PROBLEM SNM-12 *Measurement of Uterine Artery Dimensions*

The problem originator hopes to reduce the numbers of stillborn infants and incidence of birth defects by measuring the diameter of the uterine artery to provide better obstetrical care. Measurement of the uterine artery during gestation will provide additional physiologic information for insuring the birth of healthy babies. It has been practically impossible to directly measure the uterine artery diameter because physical contact can induce spasms which greatly reduce or halt the flow of blood to the fetus. He needs a nondestructive, nonconfining, uterine-artery-diameter measuring method.

A search of aerospace technology was performed and applicable documentation was retrieved. These were sent to the problem originator. The pulse-echo ultrasonic techniques hold the most promise for a solution to the problem. A custom-designed transducer assembly may be required to modify the technique and fit specifications of the immediate problem.

PROBLEM SNM-13 *Miniature pH Electrode for Fetus*

Researchers are seeking supplemental physiologic information concerning the well being of the infant as the birth process begins. Measuring the in vivo pH of the fetus during labor may provide such information. A pH probe for this purpose necessarily has unusual requirements and this complicates solution for the problem.

A computerized search of NASA technology is presently in progress to identify any relevant methodology and devices.

PROBLEM SNM-14 *Fetal ECG Telemetry*

The problem originator seeks to telemeter fetal ECG with clip-on electrodes to provide better obstetrical care, specifically during labor and birth. A transmitter will be inserted at the onset of labor to monitor continuously until birth. Bulky, hard-wire instrumentation is used for this purpose and it decreases mobility of the patient. The needed transmitter must be small enough to insert into the uterus and must be nonirritating during the course of labor. It should transmit at least 10 ft and have a useful life of 10 hr.

Search retrieved information about a NASA-designed ECG transmitter which is in the final testing stages. The instrument is sufficiently small to be used for this purpose. Data will be forwarded to the problem originator as soon as it becomes available for evaluation.

PROBLEM SNM-15 *Uterine Pressure Telemetry*

The problem originator seeks to monitor a pregnant patient's uterine pressure during labor to provide better obstetrical care. The data must be telemetered over a short distance. He currently measures the pressure by hard-wire instrumentation. This is encumbering to the patient and he feels telemetry could provide optimized care. He needs an implantable pressure telemetry unit which should be able to transmit for 10 ft, have a useful life of 10 hr, and, throughout the period, be noninjurious to the uterus or the fetus.

A search of aerospace literature retrieved relevant technology. The problem can be solved by an in-house fabrication of a pressure telemetry unit after the problem originator decides on an acceptable design.

PROBLEM DLM-5 *Measurement of Fetal Circulation from Transcutaneous Transducers and Artery Location by Depth Measurement*

The problem originator uses ultrasonic techniques to monitor fetal blood circulation during labor and delivery. The procedure detects abnormal conditions which may arise during this critical period. He uses the same transcutaneous, ultrasonic probe without changing probe location to acquire flow information and determine the distance to the artery as well as determine arterial diameter. The investigator requested available NASA technology to solve this multiple requirement.

A manual search of NASA technology was performed. The screened results were forwarded, with some additional materials, to the problem originator. A Problem Statement was prepared and sent for approval to NASA.

PROBLEM DLM-4 *Doppler Probe Holder and Stand*

The problem originator uses ultrasonic techniques to monitor fetal blood circulation during labor and delivery to determine if abnormal conditions arise during this critical period. He uses a hand-held probe to monitor the blood flow. A means of stabilization for the probe is needed for chronic measurements to reduce artifact generation from movement of the probe. The holder and stand should firmly hold the probe, but should not hold it rigidly to avoid pain during the procedure. The arrangement must be adjustable because the probe and holder must be positioned over women of various dimensions.

Interaction with NASA Langley Research Center retrieved a solution inherent in a holder which is used extensively in their work. It is operated by a lever-activated cam which quickly and firmly tightens the flexible shaft. The problem originator was furnished the information and he will obtain the holder for his use.

RESPIRATORY DISEASE DETECTION AND TREATMENT

PROBLEM OVA-3 *In Situ Measurement of Surface Tension of Lungs*

Surface tension at the fluid-tissue interface in the lungs provides an indication of the condition and efficiency of the lungs. A suitable means is needed to measure this parameter for human patients. The technique should rapidly and atraumatically measure the parameter. The technology must be reliable, safe to use, and provide automated readout. The apparatus should be portable to permit clinic and hospital ward use. It should cost less than $15,000. Little restriction is imposed on the concept.

The team performed a search of relevant aerospace technology. The screened results were sent to the problem originator and he has been informed of the state-of-the-art technology in this area.

PROBLEM OVA-2 *Measurement of Lung Compliance*

The lung volume-pressure relationship is measured by having a patient breathe into a closed system to assess function of the lungs. The data acquisition is time consuming, involves bulky equipment, and is difficult when the patient is seriously ill. The indications are suitable for bases of gross diagnosis. Subtle abnormalities or changes are not readily detectable. A reliable, convenient, and atraumatic method is needed to measure pulmonary compliance of the lung by the signaling rate and volume of airflow. It must be possible to sterilize the temperature and moisture insensitive transducer or head. It can be attached to a standard endotracheal tube through which the patient breathes, or through which he is ventilated by a respirator. Acoustic or mechanical vibration may be applicable.

The team performed an aerospace-technology search. The problem also is being circulated to NASA research centers for possible solutions.

PROBLEM GVA-6 *Respiration Monitor*

Cardiovascular patients require certain respiration studies. Analysis of the expiration cycle of tidal volume measurements are compared with the respiration rate, pO_2 and O_2 concentration to accurately describe the pulmonary well-being. The problem originator needs techniques to monitor respiration rate, pO_2, O_2 and analyze expiration waveshapes.

Data on measurement of exhaled gases were forwarded to the problem originator. A computerized search of aerospace technology was performed. Evaluation of possible approaches to the problem led to a suggestion that a respiration monitor be modified. It would control a gas analyzer to exclusively analyze exhaled air during a respiration cycle. This appears to be the best solution available.

PROBLEM NMA-6 *Demand Water-Level Float*

The problem originator needs a demand water-level float for a nebulizer. It cannot contaminate the water supply source. Nebulizers which are currently being used for inhalation therapy are being contaminated with Pseudomonas organisms. Pseudomonas organisms appear in the supply bottle within 12 hr. The designed operation of the nebulizers is for 72 hr. The water-level float operates specifically on the return air from the jet bowl. The new design of the demand float should not allow air to return to the jet and then to the supply bowl.

A search of relevant NASA technology is being initiated.

PROBLEM BLM-21 *Expired Oxygen Analysis in Respiratory Physiology Studies*

The investigator requires a method to rapidly measure the quantity or partial pressure of oxygen concentration in gaseous mixtures. This must be a reliable and accurate technique for breath-by-breath analysis of oxygen. The technology should have sufficient response time to follow oxygen concentrations throughout each breath pattern. Paramagnetic-type oxygen analyzers, currently in use, are inadequate because they are slow-responding devices. The needed instrument must continuously measure with a response time less than 40 msec, a response interval time of 1 to 10 msec, and a known and negligible latency interval.

The team performed a manual search of available NASA technology. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM GLM-15 *Respiration Volume and Rate Measurements in an Unencumbered (Free) Child*

A method is needed to measure the rate and depth of breathing of children who have been severely burned on the upper half of their bodies. Tubing should not be connected to the nose or throat. The body should not be enclosed in a plethysmograph. The method ideally should measure tidal volume of air moved into

and out of the lungs with each breath. It should avoid adding any resistance to the airway, or touching or irritating the skin.

The Beckman Instrument Company responded to a disseminated Problem Statement and described a respiratory analyzer which measures breath-by-breath. It fully meets specifications of the problem originator except for contacting the mouth by means of a small mask. This system is being evaluated for use by the problem originator.

PROBLEM SNM-10 *Portable Recording Stethoscope for Heart and Respiratory Sounds*

A small, portable stethoscope is needed to permanently record cardiac and respiratory sounds for a veterinarian bioengineer. Through the comparative analysis of heart and respiratory sounds, the treatment of the chronically ill can be enhanced. The recording-stethoscope record on tape or hard copy could also be used as a useful tool to teach or diagnose.

A NASA-developed phonocardiograph system was retrieved from an in-house communication. NASA Flash Sheet MSC-185 was loaned to the institution. This NASA instrument documentation was sufficient to permit design and fabrication of a device which solved this problem. The problem has been officially closed.

PROBLEM UTM-9 *Tidal Volume Measurement in Respiration Studies*

Quantitative data on tidal volume of air inhaled and exhaled are used, in conjunction with other physiological parameters, in the diagnosis and study of emphysema and other respiratory diseases. The problem originator exercised his patients and attempted to measure tidal volume with a pneumotachograph high-resistance transducer. The experiments were terminated before any significant data were acquired because the high-resistance transducer combined with the condition of the patients to drastically increase the respiration work function in time and amplitude. The problem originator basically needs a low-resistance airway transducer which will permit him to continue his studies as he evaluates data by hand. Eventually he prefers to automatically measure tidal volume with instrumentation.

Both problems were solved for the investigator when the NASA Data Bank retrieved document N69-13936 "Tidal Volume Air Measurement." This describes an automatic monitor with a small stainless-steel venturi transducer which is obstruction free and avoids the air resistance problem. The problem originator confirmed this estimate in his evaluation of a copy of the document. He indicated it was exactly what he required in a transducer configuration. A prototype will be fabricated in glass to proportionately increase the dimensions for human use. It will incorporate a skin diver snorkle mouthpiece for attachment.

IMPROVED SURGICAL PROCEDURES

PROBLEM NIH-1 *Hydraulic System for Hospital Cart*

Beds and tables of different heights are involved in transportation of patients and bodies to and from surgery, the recovery room, the emergency room, and the morgue. A hydraulic table or cart, to minimize lifting and provide a level stand, is needed by the nurses who must move them. The device should adjust from heights of 8 in. to 4-1/2 ft.

The problem is currently being searched through facilities of the NASA Data Bank.

PROBLEM RNV-25 *Determination of Precise Orientation of the Spine*

Orthopedic surgeons must know the precise orientation of the spine to optimally formulate surgical planning. Accurate location of the unusual geometry of the malshaped spine is inadequately defined by the most competent radiologists using the best x-ray procedures. This deficiency necessitates planning and modifying planning for surgical procedures as the surgery progresses. The problem originator requires a

better visualizing approach to accurately plot spine geometry. He suggested possibilities in the use of acoustic holography.

A literature search was considered inappropriate for this problem and a Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. An article on ultrasonic holography was retrieved and sent for evaluation to the problem originator.

PROBLEM LLU-6 *Noninvasive Minimal Encumbrance Methods for Physiological Data Acquisition*

A surgical research team at a Western university is seeking noninvasive, noncontacting methods to measure blood pressure, heart rate, respiration, and other parameters. The parameters are useful in surgery and in the intensive care ward.

Information on advanced bioinstrumentation concepts and equipment was retrieved through a literature search. Material has been sent to the problem originator and it is currently being evaluated for a possible solution to this problem.

PROBLEM OVA-1 *Indirect Blood Pressure Measurement– Without Occlusive Cuff*

The Korotkoff and ultrasonic doppler methods indirectly measure blood pressure with an occlusive cuff. An indirect method is needed to measure blood pressure without an occlusive cuff. The apparatus must be used in an operating room and intensive care environments. The number and size of encumbering wires should be minimal. The method should function in normal room acoustical noise environment and should be reasonably immune to motion artifact. Cost should be less than $2,000.

A computerized search of relevant aerospace literature was performed to include state-of-the-art blood-pressure measurement technology. The screened search results were forwarded to the problem originator. Further research is in progress for new methodology being developed.

DETECTION AND TREATMENT OF DENTAL AND ORAL DISORDERS

PROBLEM WVA-2 *Electrodes for Measuring Tooth Potentials*

New methods are being developed for predicting and diagnosing peridontal disease. Suitable electrodes are needed to measure resting potentials on the surface of the teeth. Calomel and Ag-AgCl electrodes have been tried and their stability proved to be inadequate. The electrodes must be applied to small contact areas on dry, intact teeth.

The team performed a search of NASA technology. A NASA electrode-design scientist was contacted and, after he considered the problem, he agreed to respond to it.

BASIC MEDICAL RESEARCH PROBLEMS

PROBLEM PVA-1 *Cellular Aging Caused by Ionizing Radiation, Weightlessness, and Exotic Gases*

The problem originator's research is to explain the process of aging. Certain gerontological phenomena may be explained by changes in organelles. The researcher is relating effects of ionizing radiation, weightlessness, and exotic breathing gases to aging in the cells. He has requested assistance from relevant NASA technology in this problem area.

A manual review of the aerospace indices is being prepared.

PROBLEM BLM-24 *X-Ray Exposure and Gravitational Effects on Body Functions*

Whole body responses to x-radiation are being studied to include the circulatory (blood) system, respiratory system, and kidney functions. The researcher determines the effects of gravity upon physiological changes

in an x-irradiated experimental animal. The animal is whole-body exposed to x-radiation and then placed upon a tilt table. Changes of posture are employed which are accompanied by hemorrhage or other injury. The problem originator requested available NASA technology relating to body functions in zero-gravity or partial-gravity environments.

A manual search was made of NASA literature and the screened results were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM SNM-7 *Information Theory (Shannon's) as Applied to X-Rays*

This is a mathematical theory of communication regarding a set of finite messages or events about a situation. The most natural choice is a logarithmic function when all choices are presumed to be equal and one message or event is randomly selected. Log to the base 2 has been accepted in this case. C. E. Shannon was assisted by previous work of Nyquist and Hartley to develop his information theory in 1948.

The information theory has been applied to the fields of art, music, and psychology. The investigator is determining whether or not advanced studies have been sufficient to apply the theory in clinical radiology. He is interested in any advantages of explaining a computer design based on statistical sequencing of a finite set of symbols that may characterize various radiological techniques.

A manual search was made of NASA literature. The screened search results and an article from **Scientist,** *Mathematics with Light,* were forwarded to the problem originator.

PROBLEM SNM-9 *Chemical Analysis of Biological Molecules Utilizing X-Ray Fluorescent Techniques*

The investigator is studying relaxed application of x-ray energy to the life sciences and the field of x-ray diagnosis. X-ray fluorescence has been successfully employed for elemental analysis in physical and mechanical sciences. The problem originator is seeking a method for using x-ray fluorescence as a practical biochemistry, analytical tool. He has requested NASA technology for x-ray microprobe analysis of biological molecules. He feels that expanded insight into advanced technology may develop x-ray intensities for quantitative analysis with selective excitation of molecular structures.

A manual search was made of NASA literature and the screened results were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM SNM-8 *Bone Mineral Measurement Utilizing X-Ray Techniques*

The concept of bone-mineral content determination is fundamental to interactions of x-radiation or gamma radiation with matter. The problem originator requires an x-ray machine and/or technology to provide a well-collimated monoenergetic beam of x-rays with a minimum scatter. He also needs a suitable method to detect the amount of absorbed radiation in bones. It must produce accurate and reproducible mineral determinations.

NASA technology was searched and the screened results were forwarded to the problem originator together with articles and Tech Briefs relevant to problems SNM-6 and SNM-7. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The name of a NASA bone-mineral measurements scientist was provided the team during a visit to the NASA Manned Spacecraft Center. The name was provided to the problem originator.

PROBLEM USC-11 *An Implantable Bone Pressure Transducer*

The problem originator seeks to apply external pressure during the healing process in his study of bone fracture healing. He will measure axial pressure by implanting a pressure transducer in the bone. He will

place the transducer in drilled and counterbored flat holes. Wire leads are acceptable in his planned technology.

The team plans to make a computerized search of NASA technology relating to implantable pressure transducers. This will be made available to the problem originator. In-house information concerning miniature pressure transducers will also be evaluated for application to this problem.

PROBLEM UFM-1 *Method for Determination of Maximum Stress in Long Bones*

The problem originator is developing ceramic bone replacement material. Long-bone axial and lateral stress concentrations must be calculated by a method to interface with a computer. Surgeons can be assisted in determining bone graft insertions and bone implants by a quick readout after bone dimensions have been fed in. A digital computer must be used for computations.

The team is searching for NASA-developed ultrasonics and improved radiographic methodology for a possible solution to the problem.

PROBLEM UFM-2 *Determination of Interfacing Properties of Specific Ceramic Material to Bone*

The problem originator requires technology to monitor physical, chemical, and electrical events occurring at a bone-ceramic interface after ceramic-bone-substitute implant procedures. The researcher primarily will study axial and transverse interface stresses and changes which may occur in porosity and density. He requested available NASA technology concerning primary characteristics of ceramics and other materials which could be used for this purpose.

The problem is being circulated to the NASA centers for responses.

PROBLEM SNM-4 *Improved Techniques for Measurement of Skin Thickness*

The physican indirectly measures fat and skin thickness on the body by a caliper measurement of skin fold thickness over body fat tissue. These measures of skin thickness lack the precision required for reproduction of reliable research data. The problem originator requires an accurate and precise new method to measure skin thickness. It must be compatible with procedures of obtaining skin thickness measurements as a function of time. The technology must be designed to be portable and useful under changing conditions of field research as well as under hospital conditions. It must be simple to operate, sufficiently precise to minimize experimental error, and provide a permanent record of collected data.

Only five references were retrieved from a computerized search of the NASA Data Bank. None of them were pertinent to the problem. Material on hand and that retrieved from a manual search of literature possibly may meet requirements of this problem. The data evaluation is being made by the problem originator. This problem is being classified as a potential transfer. A Problem Statement has been prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM USC-2 *Skin Elasticity Measurement*

The researcher needs a satisfactory means for quantitatively measuring skin elasticity. The clinician pinches and pulls the skin to evaluate it. He uses this test and other clinical diagnostic information to detect and evaluate the severity of Hansen's disease and certain congenital conditions or diseases. A quantitative test procedure will provide more valid information and may be performed by paramedical personnel. A suitable, temporary, mechanical connection to the skin must be able to displace the point of contact 1 cm from the normal, and provide a measure of the required tension. There must be a maximum of 2 lb tension and calibrations must be provided for displacements of 0.5 to 1 cm. Tension and displacement measurement accuracy must be ±10 percent. Tensions will be maintained for no longer than 5 sec. A visual readout is acceptable.

Few retrieved references came from a search of aerospace technology. Two possible approaches to the problem were identified. There is a skin glue developed at an Army hospital and a torque method for measuring skin condition. More information is being sought in these areas.

PROBLEM DVM-1 *Improved Measurement of the Mechanical Properties of Tissue*

The investigator requires a nondestructive determiner of mechanical properties of human muscle and tendons. Normal and abnormal states of stress, strain, relaxation, viscosity, and hysteresis of muscles and tendons will be measured. A method is required to repeatedly test live humans without pain to the patient. It may be possible to apply technology concepts for testing fiber-reinforced plastics. A biopsy sample which is as minutely small as possible may be acceptable as an alternative to nondestructive testing.

WESRAC made a computer search of NASA literature. The results were screened and forwarded to the problem originator. Promising information was retrieved from a subsequent, manual search of literature and it was forwarded to the problem originator. A Problem Statement has been prepared and sent to NASA for approval for dissemination to research centers.

PROBLEM GLM-26 *Signal Averaging and Sampling*

It is possible to record the pronounced, slow-change, DC potentials as seen in the response of animal brains to electrical stimuli. The faster, ongoing EEG activity is electronically filtered out since the DC potentials occur in addition to them. The DC potential lasts about 3 to 5 sec following the stimulation. This should be sampled at least every 0.5 sec to obtain the voltage change from the "set-point" level. This should permit averaging the signal intensity without introducing error caused by a varying DC level at the time the stimulus is given. Twenty DC shift trials or shocks must be totalled and averaged before a new set of 20 shocks is given. The shock intervals vary from 30 to 90 sec for each set. A DC Driver Amplifier of a Grass, Model 7, Polygraph which has an IRIG output jack allowing for 3 volts to a signal averager, and a Low Level DC Preamplifier are the electronics used.

The team conducted a search of aerospace literature and the problem was submitted as a candidate for dissemination.

PROBLEM GLM-27 *Repetitive Photography of Animal Behavior*

The response of an animal (rat) is to be photographed following an electric shock while a recorder provides evidence of a DC voltage change in the brain. This will correlate responses, avoid artifacts, and aid in the study of drug action. The photographic mechanism must be automatically advanced, film must be sensitive to dim light, and the mechanism must be quiet to avoid introducing sound stimulation.

A manual search was made of NASA literature and the screened results were forwarded to the problem originator. A Problem Statement was prepared and then sent to NASA for approval to disseminate to research centers.

PROBLEM GLM-28 *Animal Rewarding Keyed to Magnitude of Response*

Electric shocks applied to rats produce recordable DC brain responses of variable amplitude lasting from 3 to 5 sec. The responses are superimposed on a background DC level which slowly rises and falls. The researcher seeks to trigger a food pellet, reward-giving apparatus each time the response to a stimulus produces a DC shift of sufficient amplitude, independent of the background DC voltage level. The animal will be rewarded only when his response is correct and of sufficient amplitude to facilitate certain drug studies. The animal may be conditioned to give a larger response.

A search was made of NASA literature and the evaluated results were forwarded to the problem originator. It is expected that this NASA technology will solve the problem.

PROBLEM GVA-1 *Food and Water Intake for Small Animals in Obesity Studies*

The problem originator has a goal and interest to determine the physiological mechanisms of obesity through studies of small animals. He specifically wishes to describe and understand the mechanism of hyperphagia and obesity following lesions of the ventromedial hypothalmus and related limbic structures. He requested available NASA technology related to control of food and water intake for experimental animals. He requires a system to automatically distribute food and water according to animal weight.

Computerized searching of the NASA Data Bank retrieved a number of relevant documents which are under evaluation by the problem originator.

PROBLEM LVA-7 *Rat ECG Measurement with Minimal Encumbrance*

Rats are confined in an inflatable plastic chamber and are being studied for trace element deprivations. Rats must be handled minimally and avoid exposures to metallic apparatus. The researcher seeks an integrated instrumentation enclosure which simultaneously acquires ECG, foot pad temperature, and weight. Each test colony will contain 32 rats.

NASA-developed technology is being searched for a system to measure the three parameters.

PROBLEM LVA-6 *Rat Temperature Measurement Device*

Rats are confined in an inflatable plastic chamber and are being studied for trace element deprivations. The temperature of the rats must be taken periodically without removing them from isolation and without exposing them to metallic apparatus. Researchers have detected noticeably "cold feet" on animals that have been deprived of certain trace elements. Deep body temperature previously has been observed. The researcher seeks an integrated instrumentation enclosure which simultaneously acquires ECG, foot pad temperature, and weight. Each test colony will contain 32 rats. The method should be rapid, convenient, and minimally restraining within the isolation chamber.

A computer search of aerospace literature has been initiated for the problem.

PROBLEM LVA-5 *Rat Weighing Device*

Rats are confined in an inflatable plastic chamber and are being studied for trace element deprivations. The individual rats must be weighed periodically without removing them from isolation and without exposing them to metallic apparatus. The researcher seeks an integrated instrumentation enclosure which simultaneously acquires ECG, foot pad temperature, and weight. Each test colony will contain 32 rats. The device must operate in trace element sterile environments and be small enough to be portable and easily moved from chamber to chamber. One possible application could be an enclosure mounted on force or pressure transducers to provide a direct readout. A metallic scale with a plastic cover presently is being used. Surgery and wireless telemetry should be avoided.

The team currently has initiated a first-step literature search for the solutions to this problem area.

PROBLEM BLM-23 *Germ-Free Hamster Colony*

The experimental biology investigator requires germ-free experimental animal colonies which are developed by means of sterile caesarean surgery. The animals are nourished on a sterile diet and maintained in sterile environments. All efforts to provide these conditions with the hamsters have failed in spite of successes to produce germ-free strains of rabbits, rats, etc. Nutritional inadequacy of the synthetic milk formula diet has been suspected as the cause of this failure, but this has not been established. The investigator needs a means for hamster care in the germ-free environment in order to proceed with his work.

A manual search was made of NASA literature and the evaluated results were forwarded to the problem originator. A Problem Statement has been prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM LLU-8 *Methods for In-Flight Tracking of Medically Significant Insect Vectors*

Control of the Triatoma bug is of significance to medical entomologists because it is a carrier (vector) of Chaga's disease. This sleeping sickness disease afflicts thousands of people in Central and South America. It poses a threat to millions in this country because of the widespread presence of the Triatoma bug. The problem originator plans to track this bug in its nocturnal flights to ascertain its ranging habits and provide a means of effective controls. This bug is about the size of a large cockroach and can carry a very modest package. The investigator has applied radioactive paint and thus located them when they were inactive. He needs a method of in-flight tracking to continue his research with these insects.

Locally available NASA technology is being evaluated for possible application to this problem. A computer search has been made to retrieve relevant technology.

PROBLEM UFM-5 *Skull Cap Transducer Assembly for Neurological Studies in Cats*

The problem originator seeks to improve a transducer assembly and continue his research into the causes of epilepsy. Electrodes placed on cat brain dura are to monitor to determine the properties of epilepsy neurons after application of certain drugs. He needs a skull cap probe assembly for application of the electrodes to the dura. The assembly should be about 3 cm long by 2 cm wide, mounted 4 to 5 mm off of midline on top of the skull with 5 sensing electrodes mounted 3 to 5 mm off of midline.

Technology relevant to the solution of this problem was located and the specifications were forwarded to the problem originator. A potential transfer of aerospace technology has been achieved for this problem.

PROBLEM PVA-5 *Low Noise EEG Preamplifiers for Clinical Research*

A California researcher in experimental physiology needs a small, low-noise preamplifier which can be attached very near the EEG electrodes. The system currently in use is excessively noisy. The solution should provide a schematic since the circuitry is to be custom-packaged and this will facilitate self-fabrication.

The team currently is initiating a NASA Data Bank search.

PROBLEM LVA-1 *Lightweight EEG Preamplifier*

Potentials from probes implanted in experimental animal brains are being recorded to study the effects of certain drugs. The present system signal-to-noise ratio is insufficient to permit high fidelity recordings of brain generated voltages. Small, solid-state preamplifiers may be installed near the electrodes to eliminate or reduce noise pickup and improve the signal-to-noise ratio.

The problem has been submitted to NASA as an applications engineering project. Miniaturized NASA-developed EEG and ECG amplification devices should be adaptable to this significant research problem.

PROBLEM LVA-2 *Methods for Handling Data Related to Neurological Research on Nerve Firings*

The problem originator stimulates sensory cells of cats and manipulates feedback paths. He requires technology for handling nerve-firing-potential neurological data to provide immediate playback, storage, and analysis. A request was made for available NASA assistance with the problem area.

Information and available NASA technology were provided to the problem originator as a result of a computer search of aerospace data. Further problem identifications are in progress.

PROBLEM USC-10 *Nonsurgical Methods for Treating the Inner Ear*

Meniere's Disease has been treated by a semidestructive application of ultrasonics. There have been some indications that electromagnetic energy also has been used, according to the reference *Treatment of Meniere's Disease* M. Basey Laringo, *Laryngoscope,* 80:768, May 1970.

A computer search has been initiated for the problem. The team is awaiting results of this search for indications which will determine the further direction of investigations.

PROBLEM USC-9 *Methods for Obtaining Otological Response in Experimental Animals*

Human otological responses are measured by recording the skin potentials that are generated by eye movemement. The problem originator needs an improved methods for measuring this indirect response, or some means for measuring a direct response.

A search of available aerospace technology is in progress.

PROBLEM USC-8 *Methods for Handling Electronystagmology Data*

Otological functions are determined and otological diseases are diagnosed through recordings of electric potentials caused by lateral and azimuthal motions of the eye. A semiautomated means is needed to handle and analyze data derived from the investigator's experiments with laboratory animals (guinea pigs).

A search of available aerospace technology is in progress.

PROBLEM USC-7 *A Method for Measuring Angular Rotation of the Eye*

Electric potentials at the surface of the skin measure indications of lateral and azimuthal motions of the eye. Rotation of the eye in its orbit causes no detectable potentials. Rotation of the eye in its orbit currently must be measured by photographic techniques. The problem originator requested available NASA technology concerning clinically applicable measurements of angular rotation of the eye.

A search of available aerospace technology is in progress.

PROBLEM USC-6 *Nonocular Methods for Monitoring Vestibular System Function*

Hot or cold water applied to the ear, and observation of induced lateral and azimuthal eye reactions, is currently an acceptable otologic-function evaluation method. Temple-region skin electrodes are used in electronystagmology to measure electric potentials caused by eye movement. The problem originator requested available NASA technology related to other clinically applicable, atraumatic methods.

A search of available aerospace technology is in progress.

PROBLEM TCM-3 *Peak Detector for Signal Conditioning of Blood Velocity Measurements in Basic Medical Research*

Erythrocyte velocity is measured in microcirculation studies of capillaries which supply blood to critical organs. The problem originator intends to apply better understanding of these organs in his research of diabetes and other organ breakdown studies. Erythrocyte capillary velocity is photometrically acquired. The erythrocytes pass over two slits where two phototubes measure and present transit-time information to a correlator. The problem originator seeks to generate sharp pulses at the instant of passage to improve the methodology. Better definition of erythrocyte passage time requires technology which will read the peak analog signal and then generate a pulse at the peak.

The team is studying locally available NASA literature for application to this technological problem.

PROBLEM NMA-7 *Ultrasonic Catheter Transducer*

Determinations of artery inner-layer dye uptake by nuclear dosimetry require measurement of the inner surface layer of the artery. The diameter of the artery must be known to properly make the determination. The problem originator requires an ultrasonic transducer for pulse-echo measurements. Methodology should be nondestructive in application to animals and later to humans.

A search of available aerospace technology is in progress.

PROBLEM SRS-9 *Comparison of the Electromagnetic and Ultrasonic Doppler Blood Flow Measurement Methods*

The problem originators measure blood flow, with the electromagnetic and ultrasonic doppler methods, to comparatively determine the most reliable, accurate, and convenient technique. The problem originator requested available NASA technology concerning comparative electromagnetic and ultrasonic doppler applications to measure blood flow velocity.

The team has assembled available information and forwarded it for evaluation and comments by the problem originator.

PROBLEM LAC-1 *Method for Analyzing Blood Flow Velocity Information*

Ultrasonic doppler methods with perivascular transcutaneous and intravascular transducer obtains blood flow information in the form of undefined spectra. Accurate, *average* blood flow velocity cannot be obtained by current methods. The problem originator requires a method to handle and analyze the doppler signals which are obtained from blood flow via ultrasonic doppler techniques. The technology should provide an accuracy of ±5 percent of the actual average blood flow velocity using an intravascular catheter tip transducer. The ultrasonic Doppler catheter will be used on a clinical basis.

Current information on ultrasonic blood flow measurement was retrieved and has been forwarded to the problem originator.

PROBLEM DVM-5 *Monitoring Blood Gases*

The problem originator continuously monitors blood and CSF gases to assure an adequate level of cerebral oxygenation. He needs a catheter tip pO_2 transducer to measure spinal fluid or blood oxygen tension. The transducer must withstand sterilization and must be able to pass through a #15-gauge needle.

A manual search was made of NASA literature and the results were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. Two retrieved documents describe probes that will fit into a #15-gauge needle. This information has been forwarded by the team for evaluation by the problem originator.

PROBLEM TCM-1 *Blood Flow of Individual Cells in the Capillaries of Living Tissue*

The problem originator measures individual red cell velocity as they pass through thin tissue capillaries of certain readily visualized thin skeletal muscles and intestinal mesenteric membranes. Identical signals must be generated as a single red cell passes two photomultiplier tube windows in present equipment. Mismatched signals frequently are generated because the red cell changes shape or orientation during passage through the capillary. The problem originator needs an improved measurement of the time interval between the two signals which are generated as the red cell passes the two phototubes. He will consider an alternative solution to this problem if applicable.

A NASA Data Bank computer search was conducted and the screened results were forwarded to the problem originator. Although this search failed to provide a direct solution to this problem, some peripherally useful information was retrieved. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. This provided responses that identified commercially available technology which could be applied directly to this problem. The problem has been inactivated.

PROBLEM TCM-2 *Advanced Cross-Correlation Techniques and Equipment*

The velocity of erythrocytes in capillary beds is photometrically measured for hematology studies. Photomultiplier tubes focus on two slits to monitor erythrocyte passage time. Cross-correlation is applied to analyze the signals. The present correlator fails to accurately trigger the passage of the erythrocyte and is not sensitive enough for the sensing equipment. The problem originator requested available NASA technology suitable for interfacing into photomultiplier tube outputs, enhancing velocity measurement accuracy.

The team retrieved data from a magazine and obtained commercial materials which were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM WSM-6 *High-Power, Infrasonic Wave Generator*

The problem originator is analyzing transmission of a stress wave along fluid-filled tubes. He is primarily interested in the correlation between analog methods and generated dynamic stresses in experimental situations. He requires a generator which can be programmed by analog signals. The required pressures range from 0 to 300 mm Hg and frequencies range from 0 to 100 Hz.

NASA Ames Research Center technology appeared to have real potential for solving the problem. Arrangements were made with the center for the problem originator to borrow electrodynamic shaker equipment. Mr. Jon Jacobsen, Engineer, Department of Mechanical Engineering, University of Washington, was then placed in charge of this research. A preliminary transfer report was prepared and sent to this team. The electrodynamic shaker equipment had been used at NASA Ames Research Center in aerodynamic flutter studies and in arterial heart pulsation modeling studies. It proved to be inadequate to solve the present problem. Additional information and evaluation must be provided by the problem originator before a final transfer report can be written.

PROBLEM SWC-6 *Apparatus for Micropuncture of Pancreatic Gland*

The basic research of the problem originator relates to cystic fibrosis as it affects children. The investigator requires a subminiature electronic device to micropuncture ducts and cells of the pancreas for in vivo chemical analysis of various inorganic ions and enzymes.

Screen results of a completed search of aerospace technology have been forwarded to the problem originator.

PROBLEM NWR-5 *Numerical Methods for Solutions to Wave Equations in Layered Media of Arbitrary Cross Section*

Predictions of heating in tissues, which is caused by diathermy or ultrasound applications, are needed for this research. Fat, muscle, and bone layers are encountered that do not match classical cylindrical and rectangular shapes. Temperature rise in these layers is determined by heat dissipation and transfer. Computer solution of these problems should be easily programmed if numerical techniques can be applied. Numerical methods will also allow greater flexibility with regard to the boundaries.

The Problem Statement produced responses from the NASA Lewis Research Center and NASA Langley Research Center. Mr. John H. Lynch, Reactor Division, Lewis Plumb Brook Station, made appropriate,

specific, and detailed potential solutions. These have been forwarded to the problem originator where they are being evaluated. Several communications have been sent to remind the problem originator of the need for followup evaluations. Mr. Lynch's proposals should provide solution to the problem. Documentation of this technology transfer will be made upon receipt of competent information.

PROBLEM SVA-1 *Hand and Arm Access to Hypobaric Chambers*

The problem originator requires technology for hand and arm access to low-pressure, hypobaric chambers. This is expected to provide small volume, clean-room facilities for pharmacology research.

The team determined that NASA glove box technology was applicable to this problem. Components of the needed size were located and made available to the problem originator.

PROBLEM BLM-15 *Determination of the Physical Chemical State of Ions and Water in Living Cells*

The problem originator is determining the physical location, in three dimensions, of the sodium ions within skeletal muscle fibers and other cells. The researcher requested available NASA technology for measuring this parameter.

The screened results retrieved from a computer search of NASA data were forwarded to the problem originator. He indicated that some of them could be applied for later studies, but none solved his immediate problem. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. During a team discussion with NASA Manned Spacecraft Center researchers, an electron microprobe which can provide the required information developed as a potential solution. The electron microprobe used at the NASA Manned Spacecraft Center is not presently adaptable to in vivo determinations. The microprobe is available for use by the problem originator if it is possible to make specimen preparations.

PROBLEM JVA-1 *Fluorometry Test Sample Temperature Regulation*

The problem originator presently uses a ratio fluorometer to analyze enzymes in the hospital. The light source of this instrument has created temperature problems which have severely hampered efficient operations during research and clinical applications. Inside instrument temperature has been elevated to the point where cuvettes become overheated; this affects the validity of the results.

The team is investigating NASA technology in the areas of equipment cooling and life support in an attempt to solve the problem without extensive redesign of existing equipment.

PROBLEM SJH-1 *Interfacing Biochemical Autoanalyzers with a Computer*

The problem originator seeks to increase the efficiency of the pathology department and medical costs-to-patient by interfacing biochemical autoanalyses to a SMN-12-60 computer. He has requested available NASA technology concerning the required logic and necessary programming to acquire autoanalyzer outputs and convert them for analysis and summary by computer. He requires a fixed window or variable window gating system to peak-read autoanalyzer signals and a program to acquire a cumulative summary report.

The team learned that the NASA Manned Spacecraft Center has a computerized autoanalyzer. A team-sponsored medical information system seminar was presented in Houston, Texas, during July 1970. The problem originator attended the seminar and has requested schematics of the autoanalyzer-computer interface. This will be made available from the NASA Manned Spacecraft Center together with several computer programs which they developed for it.

PROBLEM SNM-11 *Quantitative Analysis of Polyethylene Oxide*

The problem originator is using exclusion chromatography on a preconditioned, porous-glass surface, to purify vaccines and diagnostic products when trace contamination with a conditioning agent does not

constitute a problem. He proposes to condition the porous-glass surface with polyethylene oxide. He is concerned about possible trace contamination of effluents from the chromotography columns and that this could produce a toxic effect on the purified material. The researcher needs a method for assaying concentration of polyethylene oxide, which has a high molecular weight (200,000), when it is at low concentration (10 ppm or less) in aqueous solutions of biological origin (blood, urine, sputum or tissue homogenates). Inductive methods must be employed to establish upper limits of contamination.

A search of aerospace technology retrieved related applications which presently are being evaluated by the problem originator.

PROBLEM GVA-2 *Urinalysis Techniques for Highly Volatile Compounds*

The problem originator is interested in techniques to improve urinalysis and thereby provide better diagnosis of diseases. He seeks to trap highly volatile, heretofore not-identified compounds and identify them by gas chromatography. He requested available NASA-developed technology primarily for trapping highly volatile aromatic acids in urine. The technology must trap at least 50 μg of the material and any holder or trapping chamber should be about 2 mm in diameter and 3 mm in length.

A search for applicable NASA technology is in progress.

PROBLEM LLU-4 *Compatible, Low Flow Resistance, Small Bore Tubing for Biochemical Analyzer*

The problem originator needs a low resistance, fine bore, body-fluid compatible tubing for analyzer equipment. Available tubing has a high flow resistance and is unsuitable for use in the biochemical analyzer by this researcher. The slow response of the tubing and equipment has seriously hampered his investigation and he has requested assistance from NASA technology concerning tubing materials to improve efficiency in this operation.

The team was able to provide an in-house solution to this problem and established contacts between the problem originator and a technical representative of commercial concerns for further definition of the problem and problem requirements.

PROBLEM DVM-2 *Collimation of X-Particle Beam*

The problem originator is studying the biological activity of microneuron granule cells and their precursor cells in the fascia dentata of the neonatal rat hippocampus. Cyclotron accelerated particle irradiation will be used to specifically induce selective and localized necrosis among the undifferentiated granule cell population of the fascia dentata and subependymal layer of the lateral ventricles. Visceral brain function of radiosensitive immature granule cells and adult granule cells is being investigated by the problem originator. He plans to investigate the developing hippocampus by searching for the identity, origin, and cell kinetics (cytogenesis) of the adult granule cell and immature dark cell which comprise neonatal fascia dentata and the subependymal region of the rat brain. A better understanding of these fundamental cells is needed for further study of the interaction of adult granule cells with pyramidal cells in the limbic probe.

A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. The team has made contacts with various NASA centers on this and related problems. Relevant technology may be identified through this process.

PROBLEM GLM-23 *Determination of Attractive Forces Between Red Blood Cells*

It has been experimentally determined that the effective viscosity of blood increases as a result of decompression sickness and other types of trauma. The problem originator seeks to identify changes in the attractive forces between red blood cells. He proposes to take the strongest available theories of dispersion

viscosity and examine their suitability to the study of blood. He will modify the theories as required for the specific application and then analyze available blood viscosity data.

A manual search was made of NASA literature and the screened results were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM GLM-30 *Electrical Model for Transmission of Information Within a Single Cell*

A model is needed to determine how contact information that is obtained at one end of a protozoan cell reaches the other end. The Paramecium is a single cell animal which propels itself by means of hundreds of cilia that are distributed over its surface. It presumably reverses direction of cilia beat and instantaneously reverses its movement upon contact with a mechanical or chemical interference. This presumption is valid because its forward motion is in a spiral and the reverse motion is in a reverse spiral. New electron microscopy evidence indicates a continuous fibrous network located beneath the cell surface which could serve to pass information from one end to the other, in spite of the discreditation of an impulse hypothesis by other researchers in the past. Analogy of this concept with the function of a nerve cell is poor for many reasons. The concept of translocation of simple information to rapidly cause ciliary reversal may be advanced through developments in solid state electronics. This could permit construction of a model.

The screened results of a search of NASA literature were forwarded to the problem originator. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. A copy of a recent article from **Science** on *Ciliary Orientation Control* was sent to the problem originator.

PROBLEM SNM-2 *Methods for Electrosleep and Electroanesthesia*

The problem originator requested available state-of-the-art technology regarding electrosleep induction and electroanesthesia. Repeated accounts of Russian applications of these techniques have appeared in the literature. The investigator is experimenting with animal and human subjects and sought assistance with data concerning use, techniques, behavior, physiological effects, applications, etc.

Multiple computer searches were made and the screened results were forwarded to the problem originator. Pertinent information relating to the general nature of the problem was retrieved. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM DVM-3 *Telemetry for Free-Ranging Cats and Baboons*

A 4- to 8-channel telemetry system is needed to acquire EEG and EMG information from cats and baboons. Less than a 50-ft range is required for the system. A subcutaneous or back-pack system can be used.

Retrieved abstracts were forwarded to the problem originator from results of a search of aerospace literature. Available technology was provided on multichannel, implantable telemetry systems. The problem originator has decided to build his own unit. The problem has been inactivated.

PROBLEM DLM-1 *Pressure Measurement of Brain Ventricles and Renal Arteries in the Laboratory Rat*

Misery, frustration, and discomfort are produced by arthritis and other crippling metabolic diseases. The problem originators are seeking the causes and mechanisms of the diseases through extensive neurohumeral mechanisms and hormone production research on small laboratory animals. The investigator specifically seeks to monitor pressure within the ventricles of the brain and the renal arteries of rats. He requires a miniaturized pressure transducer to implant in these locations without significantly disturbing the media surrounding the transducer. He requested available NASA technology in this problem area.

A manual search of relevant NASA literature was made and the screened results were forwarded to the problem originator. Additional information was sent to the problem originator upon his request relating to

the Whittaker Model 1007 pressure transducer and supporting signal conditions. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers.

PROBLEM DLM-2 *Temperature Measurement of Brain Core in the Laboratory Rat*

Misery, frustration, and discomfort are produced by arthritis and other crippling metabolic diseases. The problem originators are seeking the causes and mechanisms of the diseases through extensive neurohumeral mechanisms and hormone production research on small laboratory animals. The researcher specifically seeks to monitor core temperatures of rat brains. He requires a highly sensitive, miniature, temperature transducer which is to be implanted in the brain region without significantly disturbing the media surrounding the transducer. He requested available NASA technology for this problem.

A manual search was made of NASA literature and the results were forwarded to the problem originator. The investigator indicated that his staff would act on the information as soon as possible. A Problem Statement was prepared and sent to NASA for approval to disseminate to research centers. This was submitted as a potential transfer on the basis of the material obtained from the search. Problem-originator evaluation is awaited before completing the final transfer report.

PROBLEM GLM-34 *Protective Coating for Precision Optical Instruments*

A protective coating material is needed to prevent corrosion of brass. The problem originator seeks material to prevent corrosion of valuable microscopes over a long time period. The material should not affect optical surfaces or qualities of the microscope. It should not affect the ease of mechanical movements of the gears and other moving parts. The material should be clear and reasonably wear-resistant. It must be available in the small quantities needed and must be applicable to assembled microscopes having optical surfaces and lubricated mechanical elements.

A search of aerospace literature is in progress.

PROBLEM UTM-10 *Compensatory Tracking Techniques*

Much testing of attention spans and reaction times plus the ability to ignore spurious noises and random distractions are required to research conditions and techniques which allow men to simultaneously best perform multiple tasks. The problem originator requested available technology from NASA on compensatory tracking devices, tracking trainers, and any other relevant applications for this problem area.

The search of NASA literature failed to retrieve a direct solution to this problem. A member of the team was able to design the necessary signal conditioning circuitry. The problem originator is using the design to fabricate a solution package. This problem has been reported as an "impact."